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## REPORT ON THE OPHIUROIDEA

COLLECTED BY THE BAHAMA EXPEDITION FROM THE UNIVERSITY OF  
IOWA IN 1893.

BY PROFESSOR A. E. VERRILL, OF YALE UNIVERSITY.

The Bahama Expedition obtained about 66 species of Ophiuroidea, among which there are many species of great interest and several that were previously unknown.

In former years the same region had been very extensively explored by the various dredging expeditions made by Mr. Alexander Agassiz, in the Coast Survey Steamer "Blake," and by other earlier government expeditions. The various collections thus obtained were very fully worked up and the numerous new species were described by Mr. Theodore Lyman in the publications of the Museum of Comparative Zoology.\* The Challenger Expedition added a few species from the same region, which are included in Mr. Lyman's final report on the Challenger Ophiuroidea (Vol. V, 1882).

Therefore, it was not to have been expected that many new discoveries would be made, in that region, by a comparatively small number of dredgings, and with a far less elaborate equipment. Hence the number of new forms obtained by the Bahama Expedition is rather surprising.

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\*Bulletin of the Mus. Comp. Zoology, Vol. I, No. 10, p. 309, 1869; Vol. V, No. 9, p. 217, 1878; Vol. X, No. 6, 1883; also Vol. V, No. 7, p. 67, 1878, and Vol. VI, No. 2, 1879, (Challenger Coll.)

Illust. Catal. Mus. Comp. Zool., Vol. I, No. I. 1865; Vol. VI, 1871; Vol. VIII, No. II, 1875.

This collection is peculiar in lacking many common species which were taken at numerous stations and in large numbers by the "Blake Expedition". Such species belong largely to such genera as *Ophioglypha*, *Ophiomusium*, *Amphiura*, etc. These live, for the most part, on muddy or sandy bottoms, or buried just below the surface, and are only to be obtained by the use of the dredge or trawl. But as the Bahama Expedition worked largely upon the hard bottoms and used the tangles relatively much more than the dredge, the absence of many of the common species is easily understood.

On the other hand, and for the same reasons, the collection is relatively rich in those species and genera that live on hard bottoms and cling to the branches of gorgonian corals, hydroids, etc., by means of their long, coiled arms.

Such species are best obtained by the tangles. Some of these belong to the *Ophiuræ*; such as *Sigsbeia* and *Hemicuryale*; but most of them belong to the *Euryalæ*. Many of these are simple armed species of the genera *Ophiocreas*, *Astroschæma*, *Astroporpa*, *Astronyx*, *Astrogomphus*; others are of the general *Astrophyton* and *Gorgonocephalus*, in which the arms are many times forked.

Some of the long-spined genera, like *Ophiacantha*, *Ophiomitra*, *Ophiothrix*, etc., also live among the branches of gorgonian corals, or clinging to other organisms, so that they are easily captured by the tangles. Such genera are well represented in this collection.

Most of those species with long, coiled arms, adapted for clinging to the branches of gorgonian corals, are remarkable for imitating closely, in various ways, the forms and colors of the corals on which they live. This must afford them a considerable degree of protection against predacious fishes, in addition to the direct protection due to the stinging powers of the corals themselves, which is sufficient to cause most fishes to avoid them.

I have observed that some of the northern plectognath fishes (file fishes) will feed upon hydroids. It is also well

known that our northern butter-fish, when young, lives with impunity beneath the disk and among the tentacles of the great red jelly-fish (*Cyanea arctica*), which is deadly to other fishes.

It is probable, therefore, that in tropical waters many fishes have acquired comparative immunity against the poisonous stinging organs (*cnide*) of coral animals. If so, the utility of the additional protection afforded by the imitative forms and colors of so many of the coral-inhabiting ophiuroids would be obvious.

Professor Nutting has already described the colors of some of these curious forms in his Narrative of the Expedition.

In this report I have followed, in general, the order of sequence adopted by Lyman, but in the case of the *Euryalæ* and in the families *Amphiuridæ*, *Ophiacanthidæ*, and some others, I have thought it desirable to alter his classification considerably.

I have also introduced the names and in some cases the characters of the family groups, and have changed the limits of several of them. Many of these were proposed by Lütken<sup>1</sup> and by Ljungman<sup>2</sup> many years ago.

Several new families are also now characterized.

In describing the genera and species, I have generally used, as a matter of convenience, the same terms, for the organs and parts, that were used by Mr. Lyman in his various works on this group, but have made a few obvious changes. I have preferred to use *oral shield* instead of "mouth-shield", and *adoral shield* instead of "side-mouth-shield". In the genera allied to *Amphiura*, I have usually called the "outer mouth-papillæ" or papillæ of the second oral tentacle, the distal oral tentacle-scales to indicate their homology with the ordinary

<sup>1</sup>Addit. ad Hist. Ophiur., Part III; Synop. gen. Ophiur. ver., p. 87, 1869.

<sup>2</sup>Ophiuroidea viv. hucusque cognita enumerat, Ofvers. Kgl. Vetenskaps-Akad. Forhandlingar, for 1866, 1867.

tentacle-scales. The same idea has been carried out in *Ophiacanthidæ*. In the latter group I have designated the apical "mouth-papillæ" as tooth-papillæ.

In the identification of the species, I have been very much aided by a pretty large series of typical specimens of the species obtained in the West Indies by the several "Blake" Expeditions and described by Mr. Lyman. They were sent to the Yale Museum, several years ago, by Mr. A. Agassiz. I have also used, for comparison, a collection sent to me by Dr. Lütken, from the University Museum of Copenhagen.

#### ORDER I. OPHIURÆ *Müller & Troschel*, 1842.

*Ophiuræ* Ljungman, *Oph. Viv.*, p. 303, 1867.

*Ophiuridæ* Lyman, and many other authors.

*Zygophiuræ* and *Streptophiuræ* Bell, 1892.

#### Family, PECTINURIDÆ, nom. nov.

*Ophiodermatidæ* Ljung., *Oph. Viv.*, p. 87, 1867. Lutk., *Addit. Hist. Oph.*, III, p. 87, 1869.

Since the generic name, *Ophioderma*, is now recognized only as a synonym of *Ophiura*, I have changed the name of this family, as is customary in such cases. The name *Ophiuridæ* cannot properly be used for the small group here included, because Mr. Lyman and many others have always used it to designate the order *Ophiuræ*, or all the *Ophiuroidea* exclusive of the *Euryalæ*.

#### OPHIURA BREVISPIA *Say*.

*Ophiura brevispina* Say, *Journ. Phil. Acad. Nat. Sci.*, V, p. 149, 1825.

*Ophiura brevispina* Lyman, *Proc. Bost. Soc. Nat. Hist.*, VII, p. 258, Jan., 1860; *Ill. Cat. Mus. Comp. Zool.*, I, p. 18. Verrill, *Notes on Radiata*, *Trans. Conn. Acad.*, I, p. 342, 1868.

*Ophioderma olivaceum* Ayers, *Proc. Bost. Soc. Nat. Hist.*, IV, p. 134, 1852.

*Ophioderma serpens* Lutken, *Vid. Meddel.*, Jan., 1856, p. 7; *Add. ad Hist. Ophiur.*, Pt. II, p. 96.

*Ophiura olivacea* Lyman, *Ill. Cat. Mus. Comp. Zool.*, I, p. 23, 1865; Lyman, *Report Voy. Challenger*, *Zool. Ophiuroidea*, V, p. 9, 1882;



Bull. Mus. Comp. Zool., X, p. 230. Verrill, Proc. Boston Soc. Nat. Hist., X, p. 339, 1866; Report on Invert. Vineyard Sound, etc., p. 719, [363], 1873.

A variety, taken at the Tortugas, has the oral plates wider than usual. Its disk is green and the arms are banded.

A variety from Bahia Honda has narrower oral plates. Its disk is white, the arms greenish.

Several other marked varieties of this species occur. The northern form (*O. olivacea*), formerly considered a distinct species, has been treated as a synonym by Lyman in his later works. It seems to be, at least, a well marked variety.

The variety *olivacea* ranges from the south side of Cape Cod and Vineyard Sound to Charleston, S. C. It is common at Fort Macon, N. C. It is usually found in sheltered localities among eel-grass (*Zostera*).

Tortugas and Bahia Honda.

If all the forms united under this species by Mr. Lyman belong together, it ranges from Cape Cod to Bahia, Brazil.

The typical variety is common at Key West and throughout the West Indies, and also occurs at the Bermudas.

#### OPHIURA BREVICAUDA (*Lützk.*) *Lyman*.

*Ophioderma variegata* Duch. & Mich., Rad. Antill., 1850 (*t. Lyman non Ltk.*).

*Ophioderma brevicauda* Lutken, Vid. Meddel., Jan., 1856, p. 8; Add. ad. Hist. Ophiur., Pt. II, p. 94, pl. 1, fig. 3.

*Ophiura brevicauda* Lyman, Ill. Cat. Mus. Com. Zool., I, p. 16, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882.

The only specimen in the collection, referred to this species, has the arms longer and more slender than usual, with more slender arm-spines and finer granules.

Egg Key. One example.

Common at the Florida Keys and throughout the West Indies in shallow water. Colon (Bradley).

*OPHIURA CINEREA* (*Mull. & Troschel*). *Lyman*.

*Ophiura cinerea* Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 27, 1865; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882; Bulletin. Mus. Comp. Zool., X, p. 230. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 368, 1868. Nutting, Narrative Bahama Exp., p. 131.

*Ophioderma cinereum* Mull. & Trosch., Syst., Ast., p. 87, 1842.

*Ophioderma saxatilis* Duch & Mich., Rad. Antill., 1850, (*t. Lyman*).

*Ophioderma antillarum* Lutk., Vid. Meddel., p. 9, 1856; Add. ad Hist. Ophiur., Pt. II, p. 88, 1859.

Tortugas, twelve examples. Common in shallow water throughout the West Indies. It ranges to Colon and to the Abrolhos Reefs, Bahia, and Fernando de Noronha, Brazil.

*OPHIURA RUBICUNDA* (*Lutk.*) *Lyman*.

*Ophiura rubicunda* Lyman, Ill. Cat. Mus. Com. Zool., I, p. 30, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 10, 1882. Nutting, Narrative Bahama Exp., p. 131.

*Ophioderma rubicunda* Lutken, Vid. Meddel., Jan. 1856, p. 8; Add. ad Hist. Ophiur., Pt. II, p. 90, pl. I, fig. 2.

This species is conspicuously colored, even in alcohol. One example has the disk red, mottled with pale yellow; arms similar, but also with lighter and darker bands; others have the disk yellow with red mottlings on the interbrachial areas and oral shields; under arm-plates mottled; spines yellow.

In life, according to Prof. Nutting, the disk was lake-red, mottled with gray.

Tortugas, two examples.

It occurs at low water and in small depths at the Florida Keys and throughout the West Indies, and at Colon.

*OPHIURA APPRESSA* *Say*.

*Ophiura appressa* Say, Journ. Phil. Acad., V, p. 151, 1825.

*Ophiura appressa* Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 34, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 9, 1882. Nutting, Narrative Bahama Exp., p. 131.

*Ophioderma virescens* Lutken, Vid. Meddel., Jan. 1856, p. 9; Add. ad Hist. Ophiur., Pt. II, p. 92, pl. I, fig. 4.

One of the specimens belongs to a variety with unusually broad oral shields. The disk of this one is dark green, mottled with lighter, in alcohol.

Tortugas, fourteen examples.

Common at the Florida Keys and throughout the West Indies, in shallow water. It extends southward to Bahia and Pernambuco, Brazil; also to Colon, Bermuda, and Cumana.

*OPHIURA PALLIDA* *Verrill, sp. nov.*

PLATE II; FIGURE 4.

Arms five, long and slender, Remarkable for the large, broad, subcordate oral shields, crowded close to the bases of the oral papillæ; very small granulated lateral oral shields. Two very small tentacle-scales, the inner not elongated. Mouth-papillæ rather large, mostly flat or truncated, the three outer ones broadest.

Arm-spines nine, rather slender, round and pointed, the longest only little longer than the rest, equal to about one-half the length of a side arm-plate. Under arm-plates longer and narrower than in *O. rubicunda*. Upper ones short and broad, not broken, outer end slightly emarginate. Radial shields with a small, naked, distal portion, widely separated, regularly ovate. Notch at the bases of the arms angular, including three dorsal arm-plates. On the sides of the arms, at their bases and along the genital slits, are many small, naked scales. The disk is elsewhere covered with very minute granules.

The color of the arms, in alcohol, is pale brownish yellow or yellowish white, banded with a darker shade of yellowish brown; the disk is yellowish white; radial shields like the arms; beneath, the disk and arm-plates are white. The diameter of the disk of one of the larger specimens is 17 mm.; length of arms, from mouth, 90 mm.

Sta. 2 and sta. 15, off Havana, in 110 and 200 fathoms, four examples.

This species is allied to *O. rubicunda*. The latter has longer and larger oral plates, and smaller lateral oral plates; much larger and relatively stouter and more unequal arm-spines; larger and longer tentacle-scales; its color is also very different, being red or reddish brown. It also somewhat resembles some forms of *O. cinerea*, but differs in its larger radial and oral shields, and in other characters.

PECTINURA ANGULATA *Lyman*.

*Pectinura angulata* Lyman, Bull. Mus. Comp. Zool., X, p. 232, pl. III, figs. 7-9, 1883.

Bahama Banks, two examples. Taken by the Blake Exped., in the West Indies, in 88 to 248 fathoms.

OPHIOPEZA PETERSI *Lyman*.

*Ophiopeza petersi* Lyman, Mus. Comp. Zool., V, 9, p. 217, pl. II, figs. 22-24, 1878; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 13, 1882.

Sta. 19, in 1½ to 8 fathoms, off Fort Jefferson, one example. Taken by the Blake Exped. in 177 fath., in the West Indies.

OPHIOPÆPALE GOESIANA *Ljungman*.

*Ophiopæpale goesiana* Ljung., Dr. Goes, Oph., Ofv. Kong. Akad., 1871, p. 615. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 228; op. cit. X, p. 233, 1883; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 18, pl. XXXVII, figs. 4-6, 1882, anatomy; Three Cruises of the Blake, II, p. 3, fig. 393, 1888. Nutting, Narrative, p. 81, (color).

According to Professor Nutting, the color of the disk in life, is brown, conspicuously spotted with white.

Sta. 2, off Havana, 110 fathoms, ten examples.

Taken by the Blake Exped., in 38 to 250 fathoms, in the West Indies.

Family, OPHIOLEPIDÆ *Ljung.*, 1866.

OPHIOZONA IMPRESSA *Lyman*.

*Ophiozona impressa* Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 64, fig. 4, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 21, pl. XXXVII, figs. 13-15, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 235, 1883.

Off Havana, 110 to 160 fathoms, 3 examples. It occurs from Florida to St. Thomas, in shallow water.

OPHIOZONA NIVEA *Lyman*.

*Ophiozona nivea* Lyman, Illust. Catal. Mus. Comp. Zool., vol. VIII, p. 9, figs. 85-86, 1875; Bull. Mus. Comp. Zool., vol. V, p. 128, 221; Three Cruises of the Blake, II, p. 110, fig. 390, 1888.

Variety, COMPTA *Verrill*.

PLATE III; FIGURE 2, 3, 4.

The original description of this species does not apply well to a large number of specimens subsequently obtained, nor are the outline figures correct. Therefore, I have given new figures, part of them from specimens sent to me by Mr. Lyman, and have prepared the following more detailed description. The figures represent a variety with separated radial shields, which I have named *var. compta*.

Arms five, disk rather flat, rounded, covered with rather large, unequal, irregular flat plates; five larger ones, in line with the radial areas, surround a large central one, or sometimes a group of two or three or more smaller central ones; five large interradians, and five similar marginal interradians are also conspicuous, forming five interradian rows. Radial shields irregularly sub-triangular, with the broader outer ends nearly or quite in contact or separated by a row of two or three small plates; the inner ends divergent, separated by one large wedge-shaped plate and usually one or two small ones; a triangular plate which lies between their outer ends, is bordered on each side by a somewhat thickened, rather crescent-shaped plate, around which there are several small supplementary plates, and in the notch between them lie the first three small and short, dorsal arm-plates.

The oral side of the disk has, on each interradian area, four large, submarginal plates, of which the two median are larger, and usually oblong; between these and the oral shields there are usually five or six irregular and unequal plates.

The oral shields are large, oblong-oval or shield-shaped, longer than broad, the sides nearly parallel, indented, and the outer ends rounded, while the inner margins form a sharp angle. Lateral oral plates, large, elongated, curved, thickened and in contact proximally at their narrow ends.

Oral papillæ rather numerous, five to seven on each border; the next to the outer one is largest, flat, with the edge rounded; the others are mostly small, conical, and acute. Beyond the middle of the arm they become more triangular, with a slight median prominence on the outer end.

The under arm-plates are large, shield-shaped, widest distally, with the lateral edges incurved; proximal end rounded or truncate, and the outer end broadly rounded. On the basal joints they become wider and shorter, with the proximal end much narrower than the distal. Tentacle-scales on the proximal joints, two, rather large, flat, broad ovate; farther out there are often three, of which one is very small.

Arm-spines three (rarely four), small, conical, near together, well down on the sides of the arm; the upper one is usually a little smaller than the others. Upper arm-plates, except a few close to the base of the proximal half of the arm, broad-trapezoidal or triangular, with the outer lateral corners prominent and acute; the outer edge is broadly rounded; the sides nearly straight, or a little incurved, and strongly divergent; the inner end, on the proximal ones, is narrow and truncated; those beyond the middle of the arm are triangular.

The three basal plates are small and very short; the fourth is crescent-shaped; the fifth is much wider than long; farther out the ratio of the length to the breadth increases.

The diameter of the disk of the largest specimen is 16 mm.; length of longest arm, which is broken at the tip, 34 mm.



Off Havana, 110 to 263 fathoms; also from 200 fathoms, off Barbados, (Blake Exped.) Taken by the Blake Exped. in 56 to 424 fathoms.

A study of a series of specimens sent to me by Mr. Lyman (from sta. 291, 200 fath., Blake Exp.) shows considerable variation in the form of the oral shields. These are sometimes oblong, twice as long as broad, with the outer and inner portions of the same width; in other cases the outer part, beyond the lateral indentations caused by the end of the genital slit, is broader than the inner part; in other specimens the outer part is narrower than the inner. The number and arrangement of the large angular plates outside the oral shields are variable even on the same specimen. Usually there are three or four of the larger plates, of which two stand side by side, near the margin of the disk.

The radial shields are often separated distally by a row of two or three small angular plates and a large proximal plate as in our figure (pl. III, fig. 4), but in other specimens the radial shields are in contact distally, but separated proximally by a single large triangular plate, as in Mr. Lyman's type-specimen. The central disk-plate is usually closely surrounded by five large angular plates, but in many cases there are small plates intervening more or less irregularly. The variations in the scaling of the disk and in the radial shields are not coincident with the variations of the oral shields.

The varietal name is given to the variety with distinctly separated *radial shields*, regardless of the variations in the oral shields, which happen to be, in both the specimens figured, (pl. III, figs. 3 and 4) of the shorter and more ovate form.

This species is allied to *O. tessellata*. It is easily distinguished by the large, irregular disk-plates, wide, oblong, oral shields; three subequal arm-spines, low down on the sides. There are no marginal spinules outside the radial shields. The upper arm-plates also differ in form.

OPHIOTHYREUS GOESI *Ljungman.*

*Ophiothyreus goesi* Ljung., Dr. Goes, Ophi. Of. Kong. Akad., p. 619, 1871. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 22; op cit. X, p. 235; Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 28, 1882. Nutting, Narrative, p. 81.

Sta. 2, off Havana, 110 fathoms, six examples.

Taken in the West Indies by the Blake Exp. in 30 to 300 fath.

OPHIOGLYPHA ACERVATA *Lyman.*

*Ophioglypha acervata* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 316, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, fig. 6; Bull. Mus. Comp. Zool., V, 7, p. 99; Bull. Mus. Comp. Zool., V, 9, p. 218; op. cit. X, p. 242. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 39, 1882.

Sta. 26, off Key West, 60 fathoms, thirty-two examples; Sta. 41, off Sand Key, 15 fathoms, fifty examples; Sta. 54, off American Shoal, 130 fathoms, twenty examples.

Taken by the Blake Exp. in 84 to 808 fathoms.

OPHIOMUSIUM EBURNEUM *Lyman.*

*Ophiomusium eburneum* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 322, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. II, figs. 1, 2, 3; Bull. Mus. Comp. Zool., V, 7, p. 220; op. cit., X, p. 244; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Variety, *ELEGANS* *Verrill.*

## PLATE III; FIGURES 1, 1a.

This species was the type of the genus. According to Mr. Lyman's original description and figures his type differs considerably from our specimens. I have, therefore, thought it desirable to give new figures of our examples, and to describe the differences, which do not, however, appear to be of specific value. But as our specimens are only a trifle larger than his type, which was 9 mm. across the disk, the differences are probably not due to age.

Our specimens have the radial shields, broad, ovate and not widely separated, only three rows of small plates intervening, of which the lateral are minute; their inner ends are not so divergent as in the type. According to Mr. Lyman all the side arm-plates meet above and below "from the very innermost joint." In ours they do not meet above on the two basal joints and barely touch on the third. The upper arm-plates at the base of the arms are quite unlike Mr. Lyman's figure and description. The first (preceded by a smaller transverse, supplementary radial) is transversely elliptical, large, much wider than long; the next is six-sided, large, longer than broad, truncated proximally, angulated distally and laterally; the third is also rather large, longer than broad, rhombic, with the inner half longer and more acute than the outer; beyond the third the plates are of similar shape, but rapidly decrease in size, as described by Lyman. The arm-spines are *three*, instead of two, and are not all "nearly equal." They are small, short, blunt, the lowest are longest; distally the lowest one becomes more decidedly longer and stouter than the others. The under arm-plates are not all "three-sided and very small," for the two basals are rather large for the genus, somewhat five-sided, or trapezoidal, with the corners rounded and the outer end either obtusely angulated or convex.

The oral shields are longer than figured by Mr. Lyman, much longer than wide, the distal half with nearly parallel or slightly curved sides, the outer end convex, the proximal sides convergent to an acute angle, so that the form is very acute-ovate. The adoral shields are long, triangular, with their very acute proximal ends touching. The mouth-papillæ are mostly flattened and thick; the next to the outer is broadest, the others decreasing in size successively. Diameter of disk of largest specimen figured, 12 mm., length of arms about 42 mm. Diameter of disk of the smaller one figured, 10 mm.

Off Havana, 110 to 260 fath., four examples. Taken by the Blake Exp. in 92 to 500 fath.

OPHIOMUSIUM TESTUDO *Lyman*.

*Ophiomusium testudo* Lyman, Ill. Cat. Mus. Comp. Zool., VIII, 2, p. 8, pl. I, fig. 6-8, 1875; Bull. Mus. Comp. Zool., V, 9, p. 219; Lyman. Report Voy. Challenger, Zool., Ophiuroidea, V, p. 99, 1882.

Sta. 2 and 13, off Havana, in 110 fathoms, thirteen examples; sta. 56, Pourtales Plateau, in 200 fathoms, four examples. Taken by the Blake Exp. in 73 to 400 fathoms.

## OPHIOMUSIUM STELLATUM Verrill, sp. nov.

## PLATE I; FIGURES 3, 3a.

Disk nearly round, rather thin and flat, with a ten-rayed grouping of small crowded plates. Arms five, of moderate length, slender, regularly tapered, with the joints rather prominent, owing to the projecting side arm-plates. Radial shields rather large, ovate, divergent, separated by about three crowded, irregular rows of unequal overlapping plates, those of the middle row larger. A large, thickened, supermarginal, interradi al plate, nearly as large as the radial shields, occupies most of each interradi al margin, between the radial shields with which it is in contact on each side, within the outer margin, but they are separated distally from it by a small, rounded marginal plate on each side. This large interradi al plate is somewhat semicircular in form, with the convex edge turned toward the center of the disk, while its gently curved or nearly straight outer edge forms the interradi al border of the disk. From each of the large interradi al plates three or four crowded rows of small unequal plates extend inward to the central area, forming five rays, somewhat broader than the radial rays, but giving a distinctly ten rayed character to the disk-scaling. On the central area of the disk is a larger, round, central plate and ten similar primary plates can be distinguished among the small, unequal, crowded scales.

Just outside the distal end of each radial shield there is a small, thick, transversely elliptical plate, which rises prominently above the level of the radial shields and arm-plates. Distal to this there are two or three small supplementary basal arm-plates.

The under side of the disk is pretty uniformly covered by small rounded scales. Oral shields rather small, about as long as broad, somewhat heart-shaped or triangular, with curved edges; the outer end is usually slightly indented or incurved, the lateral edges a little convex, the inner end acute. Lateral oral shields oblong, a little wider distally. Mouth-papillæ squarish, about seven or eight on each side in a close row. Tentacle-pores occur on only two basal joints, each has a small rounded tentacle-scale. Under arm-plates, on the two joints having tentacle-pores, are shield-shaped or pentagonal, wider than long, broadest distally, with an obtuse inner angle; farther out they are very small, triangular or short wedge-shaped, but they are found well out on the arm.

Arm-spines three, very small, short, and nearly equal near the base of the arms, but beyond about the tenth joint the lower one is a little the longest. The upper ones becoming shorter and thicker, with a bent tip, which becomes claw-like farther out. The spines are scarcely one-third as long as a joint. Upper arm-plates very small, those beyond the basal are top-shaped or wedge-shaped, with the distal end rounded and the proximal end acute; they extend well out on the arms, or as far as the arms are preserved in our specimens.

Diameter of disk 7.5 mm.; length of longest arm (much broken at the end) 22 mm.

Off Havana, 110 to 260 fathoms, two examples.

This species is closely related to *O. cancellatum* Lyman. The latter differs in having three pairs of tentacle-pores and two tentacle-scales to each pore, smaller and shorter radial shields, more widely separated, less unequal and more numerous disk-scales; a much smaller super-marginal, interradi al plate; upper arm-plates larger and less triangular. The prominent basal arm-plate, at the ends of the radial shields, is lacking.

The type of *O. cancellatum* Lym. was taken by the Challenger Exp., off the coast of Japan, in 420 to 470 fathoms (Voy.

Chall., p. 88, pl. II, figs. 16-18). Mr. Lyman also recorded it, with a mark of doubt, from off Bermudas, in 435 fathoms. Possibly the example from the latter place may have been identical with our species.

*OPHIOMUSIUM SCULPTUM* Verrill, sp. nov.

PLATE II; FIGURE 2. PLATE VIII; FIGURE 2.

Five arms. Disk flattened, ten-lobed, owing to two projecting tubercles on each interradial margin. Upper surface covered with large plates bearing clusters of coarse granules. Five interradial plates surround a larger central one; these are surrounded by a regular circle of ten angular plates, five of which are radial and five interradial; their acute ends are directed outward so that they form a ten-rayed star; the points of the five radial plates separate the inner ends of the radial shields. The latter are larger, irregularly polygonal, nearly or quite in contact at one point, but separated distally by a large sub-triangular plate, which, like the radial shields, is unevenly verrucose and rough and bears a cluster of granules. A very large, thick, rough, and swollen bilobed plate occupies the whole of each interradial margin and extends beneath to the oral shield. The upper arm-plates are small and become obsolete at about the twelfth joint; the first one is swollen, triangular, with rounded corners, and bears a central granule. The next is smaller and more sharply triangular; the following ones decrease regularly in size to the last. The radial shields are very large, longer than broad, with the inner part sub-triangular and the outer portion transversely oblong. The outer end is truncated; the outer lateral lobes are obliquely truncated, the sides strongly incurved, the inner end acute. The lateral oral shields are elongated, narrow, and irregular. The genital slits are very narrow and sinuous. The mouth slits are very narrow. The oral papillæ are all consolidated. Tentacle-pores exist on the first two joints, each with one or two minute tentacle-scales. Under arm-plates, on the first two joints, are small shield-shaped; on three or four following joints they are minute,



triangular, and then disappear. Two very small, conical, subequal arm-spines are present on the proximal joints; they decrease rapidly in size farther out, and soon become abortive.

Diameter of disk 9 mm.; the longest broken stump of an arm is 17 mm. long; this has sixteen joints.

Off Havana, 110 to 260 fathoms, four examples.

This species is allied to *O. acuferum*, but differs in having smaller dorsal arm-plates; only two arm-spines; smaller radial shields; more numerous central disk-plates; more strongly bilobed marginal plates. In one instance one of the latter plates is broken up into four or five parts, probably due to the repair of an injury.

#### OPHIOCONIS MILIARIA Lyman.

*Ophioconis miliaria* Lyman, Bull. Mus. Comp. Zool., V, p. 221, pl. III, figs. 49-51, 1878; Voy. Chall. pp. 106, 109, pl. XXXIX, figs. 7-9, (structure); Three Cruises of the Blake, II, p. 112, fig. 395, 1888.

The single specimen obtained is somewhat smaller than Lyman's type and differs in some respects from his figures, especially in having shorter spines, longer tentacle-scales and narrower under arm-plates. It is probably the same species, however.

Disk covered everywhere, above and below, with minute rounded granules, which conceal minute, round, thin scales. Arm-spines 5 to 7, long, slender, acute, flattened, partially translucent, finely serrulate; the two upper are longer than the rest, rather longer than two arm-joints; the lowest two are shortest and most slender. Tentacle-scales two, nearly equal, elongated, flattened, blunt, more than half as long as the under arm-plates. Upper arm-plates in contact, strongly arched, top-shaped, the outer end convex, the sides a little incurved. Under arm-plates shield-shaped, longer than broad, with the sides incurved, the outer end rounded, the inner end angulated.

Diameter of disk, 6 mm.

Sta. 13, off Havana, 200 fathoms. West Indies, 163 to 450 fathoms, (Blake Exp).

Family, OPHIOTHRICHIDÆ *Ljung.*

*Ophiothricidæ* Ljung., Oph. Viv., 1866.

*Ophiothrichidæ* Lutken, Addit., III, 1869.

*Ophiothrichinæ* Ljung., Joseph. Exp., 1871.

The family is characterized by the well defined group of true tooth-papillæ; by the absence of mouth-papillæ; by the usually numerous, long, slender, generally rough and glassy arm-spines; \* and internally by the complex, interlocking articulations of the arm-bones, and the strong mouth-frames and large radial shields. The peristomial plates, in the typical genera, are in three parts; of these the middle one is large, like an oral shield. The dental plate or apical jaw-plate is a separate piece.

Nearly all the genera and species of this family live clinging closely to various sponges, gorgonian corals, crinoids, hydroids, or even to other ophiuroids. Many of them are more active in their movements than is usual among *Ophiuroidea*, and many are bright colored when living. They are mostly found in the warmer seas and in shallow water, and they are most abundant and most diversified in the East Indies. Brock enumerates fifty-six species of this family from the Indo-Pacific region. Several of the genera are known only from the East Indies or Australia.

OPHIOTHRIX ANGULATA (*Say*) *Ayres.*

*Ophiothrix angulata* Ayers, Proc. Bost. Soc. N. Hist., IV, p. 249, 1852.

*Ophiothrix angulata* Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 162, pl. I, figs. 1-3, 1865; Report Voy. Challenger, Zool., Ophiuroidea, V, pp. 216, 219, 1882; Bull. Mus. Comp. Zool., X, p. 267, 1883.

*Ophiura angulata* Say, Journ. Phil. Acad. Nat. Sci., V, p. 145, 1825.

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\*The genus *Ophiopteron* Ludw. is very remarkable for having a broad membranous web between the arm-spines, and appears to be a free-swimming form. It is from Amboina.

*Ophiothrix violacea* Mull. & Trosch., Syst., p. 115, 1842. Lyman, Ill. Cat. Mus. Comp. Zool., I. p. 164. Lutken Add. ad Hist. Oph., Pt. II, p. 150, pl. IV, figs. 1—1d, 1859. Verrill, Trans. Conn. Acad., I, p. 342, 366, 1868.

*Ophiura hispida* Ayers, Proc. Bost. Soc. Nat. Hist., IV, p. 249, 1852.

*Ophiothrix caribæa* Lutken, Vid. Meddel., p. 14, Jan., 1856.

*Ophiothrix kroyeri* Lutken, Vid. Meddel., p. 15, Jan., 1856.

Some examples from Bahia Honda have more numerous long disk-spines than usual. The same peculiarity occurs in specimens in the Museum of Yale University from Tortugas and Rio Janeiro (Univ. Mus. of Copenhagen). From Bahia Honda there are 19, partly young and half grown specimens. About one-half of these have a narrow white dorsal line on the arm, bordered by a narrow dark line of the same color as the general surface, but more intense; outside of these there is a row of irregular, angular, whitish spots, separated by dark, narrow, irregular, transverse lines; dark and light radial lines extend inward from the base of the arms over the radial shields. The rest agree with the variety *violacea* (M. & Tr.), the back of the arms being irregularly marked and spotted with whitish and dark grayish blue or brown, according to the general color. Most of these specimens have a ground-color of pale violet or grayish blue, but some are light brown; in some the arms are broadly banded with a darker tint; the under arm-plates are generally pale.

A specimen from the Tortugas is dark violet-brown with a dark brown disk and with a white dorsal stripe, but without any bordering line of darker, and without white spots except on the bases of the spines. The specimens from other localities are pale grayish or yellowish, sometimes with a pink tint, with only indistinct dorsal markings.

From Egg Key and from Station 68 there are a few young examples (disk 3 mm. to 5 mm. in diameter) in which the whole disk (including the radial shields) is closely covered with minute rough thorny spinules, without any larger spines. In the character of the arm-spines, in general coloration, and

in the mottling of the arms, they agree with the ordinary varieties of the species.

A young one, with similar disk-spinules, has the disk deep red-brown with the arms deep pink, and mottled above with whitish, in the usual manner. Those from Station 39 are pale pink with yellowish white disk; the dorsal white arm-stripe is distally bordered with red, the disk bears minute, elongated, thorny spinules, mixed with a few long, very slender, thorny spines, but the radial shields are naked, triangular, with their outer ends in contact, narrow, upturned, and prominent even in young specimens only 4 to 5 mm. in diameter.

Sta. 13, off Havana, in 200 fathoms, two examples; Sta. 39, 20 fathoms, off Key West; Sta. 68, 69, 74, off Little Cat I., 3 to 13 fathoms, three examples; Egg Key, two examples; Bahia Honda, nineteen examples; Tortugas, one example. A common species, from Cape Hatteras and Bermuda to Bahia Brazil, and throughout the West Indies, in shallow water. Colon (coll. Bradley). Fernando de Noronha (Chall. Exp.) Rio de Janeiro (Lütken).

The most northern locality recorded is N. Lat.  $35^{\circ}$ ,  $21'$ , in 16 fathoms (U. S. Fish Com).

It frequently occurs in the interstices of coarse sponges.

#### OPHIOTHRIX ÆRSTEDII Lütken.

*Ophiothrix orstedii* Lütken, Vid. Meddel., p. 15, 1856; Lütken, Add. ad Hist. Oph., Pt. II, p. 149, pl. IV, fig. 3, 1859. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 154; Bull. Mus. Comp. Zool., V, 9, p. 233. Verrill, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 226, 1882. Nutting, Narrative, Bahama, Exp., pp. 132, 211.

Those from Egg Key are mostly dark brown or dark gray, in alcohol, but all have the arms transversely banded with narrow blackish lines, narrowly bordered on each side by white lines. These triple bands alternate with the rows of spines. Narrow radial lines of the same colors extend inward on the disk, along the radial shields. The lower side of the

disk is paler brown, more or less speckled with darker brown. The under arm-plates are often bordered by whitish. Those from Tortugas are mostly larger and appear stouter, with more crowded spines on the disk. The colors are mostly greenish blue or cobalt-blue, but some are reddish brown. All are banded on the arms with triple bands of white, with darker on each side, as above. Usually the intervening bands are speckled with white or pale gray. The number of spines on the disk is variable.

According to Prof. Nutting, those dredged off Little Cat Island, in 3 to 13 fathoms, in life had the disk bluish violet, marked with radial lines of purple and white, and the arms were banded with pairs of pure white lines, enclosing bands of deep cobalt-blue.

Tortugas, forty examples; Egg Key, eight examples; Bahama Banks, eight examples; Bahia Honda, one example; Sta. 68, off Little Cat Island, 3 to 13 fathoms, one example. Common at the Florida Keys and throughout the West Indies and to Cumana in shallow water.

#### OPHIOTHRIX SUENSONII *Lütken*.

*Ophiothrix suensonii* Lütken, Vid. Meddel., p. 15, 1856; Add. ad Hist. Oph., Pt. II, p. 148, pl. IV, fig. 2. Lyman, Bull. Mus. Comp. Zool., V, 9, p. 232; op. cit., X, p. 267. Verrill, Trans. Conn. Acad., I, p. 342, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 222, 1882. Nutting, Narrative Bahama Exp., p. 221 (colors).

According to Prof. Nutting, in life the colors are very elegant. The disk is delicate lavender color, with ten sharp radiating lines of purple, running in pairs from the center to the margin, each pair enclosing a light violet stripe; four concentric purple lines run around near the upper edge of the disk; the lower side is marked by similar concentric lines of purple and white alternating; along the median dorsal surface of the arm there is a purple stripe bordered on each side by a fine white line; on the under side of the arms a similar line runs from the mouth to the tip of the arm. He states that the glassy arm-spines are nine times as long as an arm-

joint. In preserved specimens these spines are generally much broken. The pattern of the color is usually preserved, but the colors are altered.

Station 4, off Havana, 110 fathoms, one young; Sta. 41, off Sand Key, 20 fathoms, one young; Sta. 68, 69, off Little Cat I., 3 to 13 fathoms, many adult; Egg Key, three adult. Common at the Florida Keys and throughout the West Indies in shallow water. Bermuda (Goode), Brazil (Rathbun). Low water to 262 faths. (Lyman).

Family, OPHIOCOMIDÆ *Ljung.*, 1867.

OPHIOCOMA ECHINATA (*Lam.*) *Agassiz.*

*Ophiocoma echinata* L. Agassiz, Mem. Soc. Sci. Nat. Neuchatel, I, p. 192, 1835. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 81, fig. 5, 1865; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, pl. XLII, fig. 12, 13, 1882, anatomy. Verrill, Trans. Conn. Acad., Vol. I, p. 321, 1868.

*Ophiura echinata* Lamarck, Hist. Anim. sans. Vert., II, p. 543, 1816.

*Ophiura crassispina* Say, Journ. Phil. Acad. Nat. Sci., V, p. 147, 1825.

*Ophiocoma crassispina* Mull. & Trosch., Syst. Ast., p. 103, 1842. Lütken, Add. ad Hist. Oph. Pt. II, p. 142, pl. IV, fig. 7, 1859.

*Ophiocoma tumida* Mull. & Trosch., Syst. Ast., p. 100, 1842.

*Ophiocoma serpentaria* Mull. & Trosch., Syst. Ast., p. 98, 1842.

Sta. 76, off Little Cat Is., 3 to 13 fathoms, one example; Tortugas, one example. Common from Florida to Colon, and Cumana and throughout the West Indies, in shallow water. Bermudas (Goode; Verrill). Parahyba do Norte, Brazil (R. Rathbun).

OPHIOCOMA RIISEI *Lütken.*

*Ophiocoma riisei* Lütken, Vid. Meddel., p. 14, Jan. 1856; Add. ad Hist. Oph., Pt. II, p. 143, pl. IV, fig. 6. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 76. Verrill, Trans. Conn. Acad. I, pt. 2, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, 1882.

Tortugas, two large examples. Common from Florida and Bermudas to Colon and Cumana, and throughout the West



Indies, in shallow water. Fernando de Noronha, Brazil (R. Rathbun).

*OPHIOCOMA PUMILA Lütken.*

*Ophiocoma pumila* Lütken, Vid. Meddel., p. 13, Jan. 1856; Add. ad Hist. Oph., Pt. II, p. 146, pl. IV, fig. 5, 1859. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 71, 1865. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 171, 1882.

Sta. 15, off Havana, 200 fathoms, one example; Sta. 67, 74, 76, off Little Cat I., in 3 to 13 fathoms, eighteen examples; Tortugas, eleven examples. Common from the Florida Keys to Colon, and throughout the West Indies, in shallow water, to Brazil. Bermudas (Lyman; Goode).

*OPHIOPSILA RIISEI Lütken.*

*Ophiopsila riisei* Lütken, Add. ad Hist. Oph., Pt. II, p. 136, pl. V, fig. 2, 1859.

*Ophiopsila riisei* Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 150, figs. 16, 17, 1865; Bull. Mus. Comp. Zool., V, 9, p. 228. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 160, pl. XL, figs. 1-3, 1882, anatomy.

I have found it desirable to separate *O. fulva* Lym. and allied species from *Ophiopsila*, as a new genus (see p. ).

*O. riisei* appears to be closely related to the type (*O. aranea* Forbes), and like the latter, has a compact cluster of special tooth-papillæ within the margin of the jaw.

Station 13, off Havana, 200 fathoms, two examples. Bahama Banks, in shallow water, two examples; Egg Key, one example.

Throughout the West Indies and Florida Reefs. Common in shallow water. Also at Colon and Cumana, Ven. Brazil (Ljungman). Dredged by the Blake Exped. in 37 to 50 fathoms.

Family, AMPHIURIDÆ *Ljung.*, 1867.

AMPHIURA of authors, sens. ext.

In the report on the *Ophiuroidea* of the Voyage of the Challenger, Mr. Lyman recognized about ninety species of *Amphiura*. In subsequent papers by him and others, about thirty additional species have been described. This very extensive assemblage of species is evidently capable of being divided into several natural groups, in addition to the several minor groups already separated by Mr. Lyman and others. Indeed Mr. Ljungman, as long ago as 1867, set off a large number of species as a natural generic group, under the name of *Amphipholis*. At a still earlier date, Lütken had indicated this and other natural sections of the genus, without naming them.

Mr. Lyman, however, did not recognize *Amphipholis* and some other good divisions in any of his works, except as sections of the genus.

#### SUBDIVISIONS OF AMPHIURA.

The species of *Amphiura*, as adopted by Lyman, mostly fall into four large groups, which seem to be natural divisions of generic value. They are best characterized by the structure, number and arrangement of the mouth parts, as in most other ophiuran families. A few aberrant species, not found in American waters, must be referred to other groups.

##### I. *Amphiura* (restricted). Type, *A. chiajei* Forbes.

One apical or subapical mouth papilla. One (rarely two) small, distal papilla (oral tentacle-scale); middle of jaw-edge without papillæ; mouth-slits gaping. Four to seven or more (rarely three) arm-spines. Radial shields divergent.

##### II. *Amphipholis* (restricted). Type, *A. squamata* (or *A. elegans*).

Two small lateral mouth-papillæ and one broad operculiform, distal one, forming a continuous series along the entire jaw, and capable of nearly or quite closing the mouth-slits. Radial shields in close contact.

III. *Amphiodia*, gen. nov. Type *A. pulchella* (Lym.)

Three (rarely four) small subequal mouth papillæ, none of them operculiform; they form a regular series, attached mostly to the side jaw-plate. Three (rarely four) arm-spines. Radial shields often more or less joined.

IV. *Amphioplus*, gen. nov. Type *A. tumida* (Lym.)

Four or five small mouth-papillæ, none operculiform, arranged in a continuous series, of which the outermost, at least, arises from the adoral shield and is really an oral tentacle-scale. Arm-spines three, (rarely four). Radial shields generally quite separated. Disk scales naked.

AMPHIURA *Forbes* (restricted sense).

*Amphiura* Forbes, Trans. Linn. Soc., Vol. XIX, pp. 149, 150, 1842, (type *A. chiajei*) Ljungman, Ophiur. Viv., p. 318, 1867.

*Amphiura* (section B.) Lutken, Addit. Hist. Oph., II, p. 114, 1859.

*Amphiura* (*pars*) Lyman, Bull. Mus. Comp. Zool., I, pp. 335, 338; Voy. Challenger, V, pp. 122, 124, 1882.

Owing to the small number of mouth-papillæ and their peculiar arrangement, the mouth slits cannot be closed, but appear always gaping, more or less.

Only one true mouth papilla, which is placed on each side of the apex of the jaw. A single, usually spiniform, papilla, sometimes with a smaller one by its outer side, is situated at the distal end of the mouth-slit, usually attached to the edge of the adoral shield. This is really the outer oral tentacle-scale.

The edge of the jaw-plate, along its middle portion, is naked. Higher up in the mouth-slit, there is a small spiniform papilla, usually visible from below; this is the tentacle-scale of the first oral tentacle. It is often shown in published figures as if it were a true mouth-papilla. Tentacle-scales usually one or two, sometimes lacking (section *Ophiopelte*).

Arm-spines short, usually four to seven or more, (rarely three). Radial shields naked, small, generally divergent, with the distal ends either in contact or somewhat separated by small scales. The disk is usually covered with small naked scales.

In one group the under side is without scales (*Hemilepis*). In a group referred by Lyman to *Ophiocnida*, the disk is covered with small spinules, but as the mouth-parts and other organs agree with typical *Amphiura*, it might better be regarded as a distinct genus, or else as a subgenus of *Amphiura*. To this I have given the name of *Amphiocnida*. (See p. ).

The genus *Amphiura*, as here adopted, agrees nearly with the typical genus, as restricted by Ljungman in 1867. Mr. Lyman also stated that this should be the typical group, in case the genus were to be divided. This restricted genus still includes over sixty species, with a considerable diversity of structure. The species are found in all seas and in all depths.

#### AMPHIURA GRANDISQUAMA Lyman.

*Amphiura grandisquama* Lyman, Bull. Mus. Comp. Zool., I, p. 334, 1869; op. cit., p. 252; Illust. Cat. Mus. Comp. Zool., vol. VIII, pl. V, fig. 65; Voy. Challenger, Zool., V, pp. 124, 143, 1882.

Several specimens of this species in the collection have been compared with some sent by Mr. Lyman from the Blake Exp. They agree in most respects, but none of those in either lot agree perfectly with the original description.

The arms are of moderate length, slender and tapered. The disk is covered with very fine, thin, closely imbricated scales, which become still finer below. Radial shields small, longer than wide, inner end widest, adjacent edges nearly straight, outer ones curved; they are nearly in contact at the distal end, divergent proximally, separated by a long wedge-like scale and several smaller ones more proximal; the disk scaling overlaps and conceals more or less of the radial shields, in one case leaving very little exposed. Arm-spines five or

six on the basal half of the arms; they are of moderate length, rather slender, tapered; the lower one, especially on the middle part of the arm, is longer than the others, sometimes twice as long, and somewhat bent downward; the upper one on this part of the arm is often stouter and a little longer than the intermediate ones. Upper arm-plates rather broader than long, in contact, somewhat trapezoidal, with the distal end convex and the angles rounded, the lateral edges convergent, the inner end narrower and truncated; the extreme outer edge is sharp, thin, and microscopically serrulate. Under arm-plates oblong, longer than broad, with rounded corners and concave lateral edges, opposite the tentacle-pores, outer end convex, inner end subtruncate. Tentacle-scale single, rather large for the genus, thick, rounded or broad-ovate, obtuse. Oral shield small, transversely broad elliptical, evenly convex distally, inner side with a slight obtuse angle.

Adoral shields small, triangular, inner end acute; generally the inner ends are not in contact. Inner mouth-papilla short, thick, conical; outer one, (oral tentacle-scale) thicker, short-conical, obtuse; sometimes there is another rudimentary one alongside of the latter, and like it arising from the adoral shield. The inner oral tentacle has a small, thick, acute papilla in the middle of the mouth-slit, above the level of the others.

Diameter of the disk of the largest specimen, 7 mm; length of arms, about 25 mm.

Stations 54 and 58, off Florida, 130 fathoms. Taken by the Blake Exped. in 10 to 262 fathoms.

The specimens from the Blake Exped., station 319, in 262 fathoms, differ from the above in some minor points. The disk-scaling is a little less fine; the radial shields a little broader, and the arm-spines a little smaller, but they vary among themselves in these characters.

This species is allied to *O. otteri*, but has much shorter, more delicate and more tapered arms, and the lower spine is

more curved. The latter has true tentacle-scales and the disk scales are larger and more regular.

*AMPHIPHOLIS GOESI* *Ljung.*

*Amphipholis goesi* Ljungman, Dr. Goes Oph., Kong. Acad., 1871, pp. 635, 648. Verrill, Expl. of Albatross in 1883, Annual Rep. U. S. Fish Com. for 1883, p. 549, 1885.

*Amphiura goesi* Lyman, Voy. Challenger, Zool., V, pp. 125, 146, 1882.

A single mutilated specimen, without the upper side of the disk, was obtained.

Mouth papillæ three, forming a close series, the outer one flat, much the largest, as broad as the other two together, so that it occupies more than half the length of the edge of the jaw; the inner two are thick, obtuse, angular. Oral shields rather large, top-shaped, about as broad as long; the outer end is strongly convex, the sides distinctly incurved, forming an acute inner angle. Lateral oral shields crescent-shaped, rather large and thick, with concave side next the oral shields. Tentacle-scales two, oblong, rather stout, blunt, nearly equal.

Arms long, tapering but little; under arm-plates rather large, thick, in contact with each other, about as long as broad, five-sided with rounded corners; the outer edge is strongly convex and often slightly angulated and prominent in the middle, or has a slightly raised umbo, the inner end is angulated and usually has a small, rough, median projection or lobe, where it articulates with the preceding one.

Arm-spines three, short, tapered, subequal, about half the length of arm-joint. Dorsal arm-plates in contact with each other; thick, transversely subelliptical, distinctly wider than long, with the outer end broadly rounded, and the inner end obtusely angulated.

Diameter across the scar left by the disk on the arms, 10 mm; length of the longest arm (not entire) 35 mm.

Off Havana, 110 to 200 fathoms. West Indies, 280 fathoms (Lyman). Off Cape Hatteras, 14 fathoms (Verrill).



AMPHIPHOLIS TENERA (*Ltk.*) *Ljung.*

*Amphiura tenera* Lütken, Addit. ad. Hist. Ophiur. Pt. II, p. 124, pl. III, figs. 5a, 5b, 1857. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 123.

*Amphipholis tenera* Ljung., Ophiur. Viv., Kong. Akad., 1866, p. 312; op. cit., 1871, pp. 634, 645.

Disk rounded, thin, flat, covered with numerous small rounded scales, regularly arranged. Those along the margins with their edges a little turned up, so as to form a slight border. Radial shields rather crescent-shaped, in close contact. Arm-spines three, slender, tapered, nearly equal in length, but the middle one is distinctly swollen toward the base; they are about as long as the length of an under arm-plate. Tentacle-scales two, small, oblong, blunt, about equal in size. The outer mouth papilla is flat, much the broadest, occupying about half the length of the mouth-slit; the middle one is small, subconical; inner one a little larger.

Oral shields top-shaped, about as long as broad, the outer end strongly rounded, the inner sides nearly straight and convergent to an acute angle. Lateral oral shields relatively large, oblong, a little wider distally, the inner ends largely in contact.

Under arm-plates oblong shield-shaped, decidedly longer than wide, outer end convex, sides nearly straight, inner end angulated; they are strongly separated by the side-plates.

Upper arm-plates relatively large, rather broader than long, subtriangular, the outer end broadly rounded, the inner end obtusely angulated; they are well separated by the side plates.

Diameter of the disk of the specimen described, which is not full grown, 2 mm; length of arms (broken at tips), 9 mm.

Off Havana, 100 to 200 fathoms. Charleston, S. C., to West Indies, in shallow water.

Mr. Lyman, in the Voyage of the Challenger, united this species and several other forms that have been described as

distinct species from various regions, with *A. squamata* of Europe.

This West Indian form appears to me to be distinct, though very closely allied to *A. squamata*. I have described, above, a small but characteristic specimen, which agrees very closely with Lütken's original figures.

AMPHILIMNA, gen. nov. Type, *A. olivacea*.

Mouth papillæ four or five in a series. Tooth papillæ two to four. Arm-spines six to ten, of moderate length. Tentacle-scales usually two. Disk swollen dorsally, with a notch over the base of each arm, and covered with spinules. Radial shields parallel, largely in contact. This genus includes, besides the type, only *A. caribea* Ljung.

AMPHILIMNA OLIVACEA Ver.

*Ophiocnida olivacea* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 340, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 7, 8; Bull. Mus. Comp. Zool., V, 9, p. 227; op. cit., X, p. 253. Verrill, Amer. Journ. Sci., Vol. XXIII, p. 219; Ann. Rep. U. S. Fish Com., Vol. X, p. 661; op. cit., Vol. XI, p. 549; Lyman, Report Voy. Challenger, Zool. *Ophiuroidea*, V, p. 156, 1882.

Sta. 61, off Key West, in 75 to 80 fathoms, one example.

Taken by the U. S. Fish Comm. at numerous stations off the east coast of the United States, from off Martha's Vineyard to Cape Hatteras, in 63 to 192 fathoms, and by the "Blake" from off Rhode Island to the West Indies, in 40 to 126 fathoms.

It is possible that *A. caribæa* (Ljung.) from the West Indies, is the young of this species.

OPHIONEREIS RETICULATA Lütken.

*Ophionereis reticulata* Lütken, Add. ad Hist. Oph. Pt. II, p. 110, pl. III, figs. 6a, 6b, 1859. Lyman, Ill. Cat. Mus. Comp. Zool., I, p. 141, 1865; Bull. Mus. Comp. Zool., V, 9, p. 224; op. cit. X, p. 253. Verrill, Notes on Radiata, Trans. Conn. Acad., I, pp. 342, 366, 1868. Lyman, Report Voy. Challenger, Zool., *Ophiuroidea*, V, p. 162, pl. XL, figs. 13-15, 1882, anatomy.

*Ophiura reticulata* Say, Jour. Phil. Acad. Nat. Sci., V, p. 148, 1825.

*Ophiolepis nereis* Lütken, Vid. Meddel., p. 11, March, 1856.

Tortugas, four examples; Bahama Banks, two examples; Egg Key, one example; off Havana, 110 fathoms, 1 example.

Common in shallow water from Florida to Colon; Cumana, and throughout the West Indies. Bermudas (Coll. Goode); Abrolhos Reefs, Brazil, (Coll. Hartt). Bahia and Rio de Janeiro (Rathbun).

#### OPHIOPLEX LJUNGMANI *Lym.*

*Ophioplax ljunmani* Lyman, Ill. Cat. Mus. Comp. Zool., Vol. VIII, p. 22, pl. II, figs. 24, 25, 1875; Voyage Challenger, pp. 164, 314, pl. XLI, fig. 7 (anatomy).

Sta. 13, off Havana, 200 fathoms, 6 examples.

Taken by the Blake Exped. in 80 to 250 fathoms.

#### OPHIACTIS DISPAR *Verrill*, sp. or var. nov.

##### PLATE VIII; FIGURES 3—3e.

Arms five. Radial shields large, elongated, semielliptical, separated by a single narrow row of small plates, except distally; their inner edges nearly straight, diverging but little; distal end thickened, bearing a small round knob; lateral edges convex. Central and interradian areas covered with pretty regular, small, very distinct scales, many of which bear small conical spinules, especially near the center and close to the margin. Arm-spines, six to eight; four, or sometimes five of the lower ones are white, short, subequal, flat at tip, blunt, nearly parallel, and close together, two or three of the upper ones are decidedly longer, abruptly different in color and form, divergent, tapered, acute. Mouth-papillæ two, small, flat, placed close together, on each side of the distal part of the mouth angles, just above the outer oral tentacle; one small, oblong, flat, blunt tentacle-scale. Under arm-plates about as long as broad, with the outer edge subtruncate or rounded and with a thickened and raised rim; distally they become longer than broad. Upper arm-plates trans-

versely elliptical, short, with the outer edge evenly convex; they are somewhat thickened and broadly joined.

Oral shields small, transversely broad-elliptical, convex and slightly angulated distally, obtusely angulated on the inner end. Madreporic shield decidedly larger and more rounded. The large genital slits nearly reach the oral shields; their inner ends are separated only by a narrow isthmus, covered by two narrow genital scales, which join the outer end of the oral shield. Adoral shields small, trilobed, the acute inner ends separate, or sometimes barely touching.

Color of one example deep green above, with small white spots on the outer end of the radial shields, on the central part of the disk, and on the upper arm-plates. Under side whitish, the arms becoming greenish distally. The four lower arm-spines are white; the two or three upper ones are green. Another example, from station 69, is greenish black above, with fewer white markings, but whitish below.

Diameter of disk, 7.5 mm.; length of longest arm, broken at tip, 44 mm.

Stations 69 and 74, Bahama Banks, in shallow water.

Mr. Lyman sent to me, several years ago, several specimens essentially like those described above, but of still larger size, as "*O. mülleri*, var. *quinqueradia*." This variety name, first given in 1878, appears in the Voyage of the Challenger (pp. 113, 115), but with no definite description nor figure.\* I am not aware that it has been described elsewhere under that name. In his earlier work † Mr. Lyman described a

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\*This name appears without description in Bull. Mus. Comp. Zool., vol. V, p. 224, 1878. The specimens were from Key West and vicinity in shallow water (shore to 37 fath).

In the Voy. Challenger, p. 113, in the analytical table, it is mentioned as the *adult* of *O. mülleri*, and is said to have: "Upper arm-plates transverse oval and not thickened; three or even four mouth-papillæ on a side." In the specimens sent to me the upper arm-plates are thickened and there are three small mouth-papillæ.

†Illust. Catal. Mus. Comp. Zool., I, p. 109, 1865.

five-rayed variety of *O. mülleri*, but it was of small size and agreed in all other essential characters with the ordinary, small, six-rayed variety *O. mülleri*. At that time he gave it no varietal name.

The large specimens sent by Mr. Lyman differ from the types of *O. dispar* only in characters of small importance due, probably, to greater size.

The arm-spines are longer and the lower ones rather less differentiated from the upper ones; they are rather more slender and not so much flattened and increase a little more gradually in length from the lowest upward. The large radial shields are semielliptical, much as in our type. The upper arm-spines are regularly elliptical, and thickened. The under arm-plates are, as in our types, thickened and turned up at the distal and lateral margins, but many of them are slightly emarginate at the outer end, becoming truncate more distally. The oral shields are more rhombic, about as long as broad, with a small peak or acute angle on the outer end where it joins the genital scales; obtusely angled proximally. Adoral shields not touching proximally. Mouth papillæ three on most of the oral margins, small, flattened, the outer one (sometimes two) arises from the edge of the adoral shield above the outer oral tentacle and might be called an oral scale. The first oral scale is well developed, higher up in the mouth-slit.

Large clusters of minute eggs were attached around the mouth and between the groups of spines near the bases of the arms of our specimen.

Diameter of disk, 11.5 mm; length of arms, 70 mm.

It is not probable that the specimens above described are the adults of *O. mülleri*. They are much more like *O. krebsii*, and may, possibly, be the adults of the latter. It seems to me most probable that the specimens to which Mr. Lyman first applied his varietal name in 1878 were unlike those that he afterwards sent to me from another locality.

The former were very likely the real adults of *O. mülleri*, as he supposed. Therefore I think it best to apply a new name to the form above described. Whether it be a variety or the adult of *O. krebsii*, or a distinct species, can only be determined by a larger series of intermediate sizes.

OPHIACTIS KREBSII Lütken.

*Ophiactis krebsii* Lütken, Vid. Meddel., p. 12, 1856; Addit. ad Hist. Oph., Pt. II, p. 126. Lyman, Ill. Cat. I, p. 111, figs. 10, 11. Verrill, notes on Radiata, Trans. Conn. Acad., I, p. 341, 366, 1868.

*Ophiactis savignyi* (pars) Lyman, Report Voy. Challenger, Zool. Ophiuroidea, V, p. 115, 1882.

Bahama Bank, 12 young. Common from Charleston. S. C. and Florida Reefs to the Abrolhos Reefs and Rio de Janeiro, Brazil. Bermuda (Coll. Goode). It lives in the interstices of sponges and corals, often gregariously while young.

Mr. Lyman considered it identical with *O. savignyi* and *O. virescens*, from the Indian and Pacific oceans respectively. With this opinion I am not prepared to agree.

*O. dispar* appears to me to be more nearly related to *O. krebsii* than to *O. mülleri*. The former has, even when of very small size, with six rays, two mouth papillæ, instead of one. Its ventral plates have also a thickened or raised margin as in *O. dispar* and the arm-spines are more unequal and more numerous than in *O. mülleri*. It is possible, therefore, that the ordinary specimens of *O. krebsii* are all very young and that when they grow to full size they may become regularly five-rayed, as do some other echinoderms that undergo spontaneous fission and have a variable number of arms while young. In that case it might, perhaps, develop into a species like *O. dispar*.

Family, OPHIACANTHIDÆ Ver.

*Ophiacanthinæ* (sub-family of *Amphiuridæ*) Ljungman, 1866; Lütken, 1869.



This family, as here understood, includes the following described genera: *Ophiacantha*, *Ophiomitra*, *Ophiotrema*, *Ophiocamax*, *Ophiolebes*, *Ophiothamnus*, *Ophiocopa*, *Ophiochiton*, *Ophiotoma*, and probably *Ophioblennia*. To these I have now added several others, separated from *Ophiacantha*, *Ophiomitra*, and *Ophiopsila*.

The first six of those named above have the disk covered with scales bearing spinules or thorny processes, or sometimes granules. *Ophiochiton* and *Ophiocopa* have naked or nearly naked scales. *Ophioblennia* and *Ophiotoma* are covered with naked skin. The radial shields may be large or small, naked or concealed.

The family is characterized by the prominent and highly developed side arm-plates, usually meeting above and below, and by the numerous, usually long, and more or less rough spines, which stand out at nearly right angles to the arm. The spines may be solid or hollow, glassy or opaque, terete or flat.

The mouth-papillæ are usually rather numerous, and form a continuous row along the side of the jaw, but the outer ones may be of larger size or different in form from the others, or clustered, and in such cases they are really the distal oral tentacle-scales. There may be only a single apical tooth-papilla, or there may be two or three, and sometimes there is a large cluster. In some cases the outer oral tentacle-pore is exposed to view on the outer margin of the jaw and then it has one, or sometimes several, special oral scales or papillæ by its outer side, or partly surrounding it. Some of its scales may be attached to the adoral plate, or even to the first under arm-plate. This plate is usually concave or somewhat bilobed, and has two inner, lateral, scale-like processes, which are sometimes movable and papilliform. There is generally a single acute tooth-papilla at the tip of the jaw, but there may be two or three, and in some cases (*Ophiocamax*, *Ophiomitra*, *Ophiotrema*), there may be a cluster of several spiniform tooth-papillæ. These were counted as mouth-papillæ

by Mr. Lyman, but when they stand on the dental plate they should be considered as true tooth-papillæ. The teeth are stout, flattened, obtuse; they vary from three to eight in number.

*Dichotomous analytical table of the East Coast and West Indian species that have been referred to Ophiacantha, (sens. ext.)*

[The species are grouped in this table as nearly in accordance with their structural relations as possible. Those marked with an asterisk are from the eastern coast of the United States north of Cape Hatteras. The others are from the West Indian region.]

A.—Oral shields join the first side arm-plates. Adoral shields entirely proximal to the oral shields.

B.—True *Ophiacantha*. Disk wholly, and radial shields mostly covered with small crotchets, thorny stumps, or short spinules or granules, or with a mixture of these forms.\*

C.—Disk covered with small crotchets, or short thorny stumps, or short spinules, with no elongated spines nor granules.

d.—Arm-spines finely serrulated, or nearly smooth under a simple lens, usually long and tapered, not glassy.

e.—Basal opposite rows of arm-spines, in the adults, approximate dorsally.

f.—Mouth-papillæ form a simple row.

\* *O. bidentata* (Retz.)

\* *O. aculeata* Ver.

\* *O. fraterna* Ver.

\* *O. abyssicola* Sars.

\* *O. anomala* Sars.

*f. f.*—The distal oral papillæ, or oral tentacle-scales, are clustered or form a double row; all spiniform. Tentacle-scales spiniform.

\* *O. enopla* Ver.

*e. e.*—Basal rows of spines not very closely approximate dorsally. Mouth-papillæ in a simple row.

\* *O. fraterna* Ver.

*O. cosmica* Lym.

*d. d.*—Arm-spines decidedly thorny or prickly, and usually glassy, mostly long and slender.

*g.*—Basal rows of spines approximate dorsally. Side arm-plates very prominent. Disk with small slender crotchets or branched spinules.

*O. aspera* Lym.

\* *O. millespina* Ver.

*O. pentacrinus* Ltk.

*O. scutata* Lym.

*g. g.*—Basal rows of spines not closely approximate dorsally. Disk with short thorny stumps.

*O. stellata* Lym.

*C. C.*—Disk entirely covered with tapered spinules or true spines, or having more or less of them mixed with granules or other structures, or else covered with granules only.

*h.*—Disk covered with spinules, only, or else having spinules mixed with other structures, not granulated.

*i.*—Disk with spinules only or mainly.

*j.*—Basal rows of spines approximate dorsally.

\* *O. spectabilis* Sars.

*j. j.*—Basal rows of spines not approximate dorsally.

*k.*—Arm-spines finely serrulate, not glassy. Tooth-papillæ single. Mouth-papillæ in a simple row.

*O. segesta* Lym.

\* *O. crassidens* Ver.

*k. k.*—Arm-spines thorny and glassy. Disk-spines slender, thorny, acute. Several tooth-papillæ.

*O. pectinula* Ver.

*i. i.*—Disk bearing few tapered spines mixed with other structures. Rows of spines approximate dorsally.

*l.*—Disk covered with granules, mixed with a few tapered spines. Arm-spines finely serrulate or nearly smooth.

*O. vepratrica* Lym.

*l. l.*—Disk-spines elongated, mixed with crotchets or thorny stumps. Arm-spines more or less finely serrulate.

\* *O. varispina* Ver.

*h. h.*—Disk covered with small close granules alone. Basal rows of spines not closely approximate dorsally. Arm-spines serrulate. Under arm-plates short and broad, well separated.

\* *O. granulifera* Ver.

*B. B.*—Radial shields largely uncovered. Disk-scales either partially naked and easily visible, but bearing more or less granules or spines, or else entirely concealed.

*m.*—Disk-scales largely exposed.

*n.*—*Ophialcea* V. Dorsal arm-plates largely in contact. Arm-spines nearly smooth. the opposite rows widely separated dorsally.

*O. nuttingii* Ver. sp. nov.

*O. rubescens* (Kœhl.) off Azores, 845 meters.

*n. n.*—*Ophiomitrella* Ver. Dorsal arm-plates separated by the side plates. Arm-spines slender, thorny, the basal rows approximate dorsally.

*O. lævipellis* (Lym.)

*m. m.*—Disk-scales mostly concealed, but radial shields naked.

*o.*—*Ophiacanthella* Ver. Basal rows of spines not approximate dorsally. Dorsal arm-plates largely in contact. Radial shields long, mostly naked, in contact by their edges. Arm-spines nearly smooth. Three tooth-papillæ; mouth-papillæ four, conical, all similar.

*O. troscheli* (Lym.)

*o. o.*—*Ophioscalus* (p. 42) Dorsal arm-plates separated. Basal rows of spines closely approximate dorsally. Radial shields large, broad, naked, in contact for nearly their whole length. Two or three tooth-papillæ. Arm-spines thorny and glassy.

*O. echinulata* (Lym.)

*A. A.*—The oral shield is separated from the side arm-plates by the distal lobe of the elongated adoral shields.

*D.*—*Ophiopristis* Ver. Adoral shields narrow, trilobed, the narrow distal lobe separating the oral shield from the side arm-plate. Disk-scales usually concealed by cuticle and spinules.

*E.*—*Ophiopora*, gen. nov. (See p. 43). No tentacle-scales, the pores are very large, spines small, usually smooth.

*O. bartletti* (Lym.) One spiniform distal oral papilla by the side of the oral tentacle-pore. Disk covered with acute spinules.

E. E.—One or two tentacle-scales.

*p.*—*Ophiolimna*, gen. nov. (See p. 44). Arm-spines seven or eight, nearly smooth, placed obliquely on the distal part of the plates, not strongly divaricate. Jaws more or less granulated. Disk-scales and radial shields concealed, bearing granules and spines.

\* *O. Bairdii* (Lym.) Upper arm-plates separated. Rows of spines approximate dorsally. Tentacle-scale single.

*O. mitra* Lym. Upper arm-plates joined. Rows of spines wide apart dorsally. Two flat tentacle-scales.

*p. p.*—*Ophiopristis*, gen. nov. (see p. 44). Arm-spines serrulate, not obliquely placed. Strongly divaricate. Dorsal arm-plates separated. Tooth-papillæ usually three.

*q.*—Spines partly flattened, serrulate on the edges. A row or cluster of several distal oral papillæ at the large, oral tentacle-pore. Two tentacle-scales on the basal joints.

*O. hirsuta* (Lym.)

*O. ensifera* Ver. sp. nov.

*O. cervicornis* (Lym.)

*q. q.*—*Ophiotreta* Ver., subgen. nov. Only one or two, rarely three, oral tentacle papillæ, which are flat. Two to four or more tooth-papillæ. Arm-spines terete, or only a little flattened, slender, serrulate or nearly smooth.

*O. lincolata* (Lym.)

*O. sertata* (Lym.)

*D. D.*—*Ophiothamnus* Lym. Adoral shields large, wedge-shaped, with the broad distal end separating the narrow ovate oral shield from the side arm-plate. Disk-scales exposed. Radial shields more or less naked, close together.



*O. gracilis* (Ver.)

*O. vicarius* (Lym.)

*O. exigua* (Lym.)

From the old genus *Ophiacantha* several genera and subgenera may now be separated with characters that appear to be of as great morphological value as those that characterize, for instance, *Ophiomitra* or *Ophiochiton*.

The most important of these are here indicated.

#### SERIES I.

##### OPHIACANTHA (restricted).

Types, *O. setosa* and *O. bidentata*.

##### Section A.—Typical *Ophiacantha*.

To this section a large majority of all the described species belong.

##### Section B.—*Ophientodia*, subgenus nov.

Two, three, or four tooth-papillæ clustered at the tip of the jaws. Otherwise nearly as in section A. Distal oral papillæ not clustered.

The figures of several species show two paired papillæ, directed centrally, at the tip of the jaws. They may not always stand on the dental plate and in such cases should be counted as mouth-papillæ, but in some cases they have been determined as true tooth-papilla. Probably in this section there may be a central tooth-papillæ that has been over-looked in some species, by reason of its position, higher up on the jaw, or the smaller size. In some cases the central papilla is present on some jaws, but absent on others of the same specimen. It may have been accidentally lost in some examples. Therefore, I consider the presence of

three tooth-papillæ as the usual character of this division. The species need revision as to the tooth-papillæ.

*a.*—Radial shields rather small, narrow, mostly concealed.

*O. scutata* Lym.

*O. cuspidata* Ver.

*O. pectimula* Ver.

*a. a.*—*Ophioscalus*, nov. Radial shields large, wide, closely joined, naked. Disk-scales covered with rough spinules. Arm-spines approximate dorsally.

*O. echinulatus* (Lym.)

Section C.—*Ophictodia*, subgenus nov.

Outer mouth-papillæ (oral tentacle-scales) several, forming a cluster or a double row, some often standing on the lower face of the jaw or adoral shield. Tooth-papillæ one to three, or more. The mouth-papillæ are clustered nearly as in typical *Ophiomitra*.

*O. enopla* Ver.

*O. rosca* (Lym.)

*O. spectabilis* (Sars.)

## SERIES II.

Group D. *Ophialcea*, (subgen. nov.) Types, *O. nuttingi* (Ver.) and *O. tuberculosa* (Lym.) (See p. 38).

The dorsal arm-plates are broadly in contact, at least on many of the proximal joints. Disk-scales bear spinules or granules. Radial shields separate, sometimes more or less exposed distally, sometimes covered. Arm-spines rather short, few, nearly smooth, the rows not approximate dorsally. Mouth-papillæ nearly as in typical *Ophiacantha* (group A).

*O. nuttingii* Ver., sp. nov. Arm-spines four, short. Oral shield very large, ovate. Disk-scales more or less exposed, bearing spinules.

Group F.—*Ophiomitrella* Ver., gen. nov. (See p. 39).

Type *O. lævipellis* (Lym.)

Disk-scales visible, bearing granules or spinules. Radial shields partly naked, not large, wide apart. Arm-spines slender, thorny or serrulate; the rows approximate dorsally in the type. One tooth-papilla. In the type-species a pair of special, distal, oral tentacle-papillæ, on the first under arm-plate, \* directed into the mouth-slit. Adoral shields wide. Otherwise the mouth-parts are nearly as in typical *Ophiacantha*.

*O. lævipellis* (Lym. '83). Arm-spines eight, slender, thorny. Disk-scales naked or partly granulated. Upper arm-plates separated.

Group G.—*Ophiacanthella*, gen. nov. Type, *O. troscheli* (Lym.)

Radial shields naked, long, parallel, united by their edges. Dorsal arm-plates largely joined. Three tooth-papillæ. Arm-spines nearly smooth. (See p. 39.)

### SERIES III.

In the following groups the oral shield is separated from the side arm-plates by the adoral shields:

Group H.—*Ophiopora*, gen. nov. Type. *O. bartletti* (Lym.)

Tentacle-pores all large and open. No tentacle-scales. (See p. 39.)

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\*The two papilliform appendages of the first under arm-plate are here supposed to be movable, but with the published figures and descriptions it is not always possible to distinguish them from the solid, immovable crest-like lobes, which are present on these plates in the same position in many species, including *O. bidentata*. Among extralimital species, these papillæ are found in some species, such as *O. serrata* Lym., that have the disk-scales and radial shields concealed.

Group I.—*Ophiolimna*, gen. nov. Type, *O. bairdii* (Lym.)

Spine-crest of the side arm-plates oblique and situated distally. Spines nearly smooth. Disk granulose and spinulose. Jaws more or less granulose. (See p. 40.)

Group J.—*Ophiopristis*, gen. nov. Type, *O. hirsuta* (Lym.).

A row of distal oral papillæ alongside of the large, outer, oral tentacle-pore. Arm-spines partly flattened, with serrulate edges. (See p. 40.)

Group K.—*Ophiotreta*, subgen nov. Type, *O. lineolata* (Lym.)

One or two flat, distal oral papillæ by the side of the large oral tentacle-pore. Two or three tooth-papillæ. Spines mostly terete, sometimes flattened and serrulate on the edges. (See p. 40).

### *Description of Species.*

#### OPHIACANTHA ASPERA Lyman.

*Ophiacantha aspera* Lyman, Bull. Mus. Comp. Zool., V, 9, p. 228, pl. I., figs. 10-12, 1878; op. cit., Vol. X, p. 263, 1883. Lyman, Report, Voy. Challenger, Zool., Ophiuroidea, V, p. 199, 1882.

The specimens collected show some minor variations among themselves and differ considerably in details from Mr. Lyman's figures.

The disk is densely covered with minute thorny spinules, terminating in two to five or more short divergent points; toward the margin they are longer, mostly with two or three points. The mouth papillæ are rather large and project downward; there are sometimes 4, but oftener 3; they are crowded and the innermost one is vertically compressed; the two outer ones are often longer and larger, somewhat enlarged and cuspidate at the end, and often rough with little prominences like incipient thorns, showing a tendency to the structure of the peculiar tentacle-scales; the two stand close

together and all arise from the buccal plate; one stout terminal tooth-papilla. The oral shield is nearly as figured, but the outer end is a little more prominent and the sides are a little incurved at the genital slit; the inner sides are also a little more incurved. The adoral plates are thickened and lunate, nearly as large as the oral shields. All these shields form together a rhombic figure and with the small concave first arm-plate they form a raised pentagon around the mouth. The tentacle-scale is more acute than figured, and has longer thorns, which are divergent like branches; distally it becomes slender and delicate, with few very acute branches. The arm-spines are very slender and very thorny, about ten in a row; they are so numerous and crowded as to conceal the arms above. The rows are closely approximate above, on six or more joints, and tubercles at the bases of the upper ones in opposite rows touch on the median line on the first two joints. The spine-ridges are so thick and prominent that they give a beaded appearance to the arm. Upper arm-plates are very small, quadrant-shaped, and widely separated. Under arm-plates are not just as figured; they are narrow, rather oblong, scarcely "shield-shaped" for the inner end is nearly truncate or slightly convex, without a distinct angle, and the outer end has a central lobe or prominence, which is a little roughened at the margin. The second plate differs from the rest; it is transversely lozenge-shaped, broader than long, but has the outer median lobe.

Diameter of disk, 5 to 6 mm.

Station 13, off Havana, 200 fathoms, five examples. Taken in various localities in the West Indies by the Blake Exp., in 73 to 262 fathoms.

#### OPHIACANTHA STELLATA *Lyman*.

*Ophiacantha stellata* Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 11, pl. II, figs. 16-18, 1875; Ophiuroidea, V, p. 199, 1882; Bull. Mus. Comp. Zool., X, p. 262, 1883.

Sta. 13, off Havana, 200 fathoms, one example.

Taken by the "Blake" at many localities, in 56 to 262 fathoms.

*OPHIALCÆA Verrill*, subgen. nov. (See p. 42.)

*OPHIACANTHA* (*OPHIALCÆA*) *NUTTINGII Verrill*, sp. nov.

PLATE I; FIGURE 2. PLATE VIII; FIGURES I—IIa.

Five arms. Disk five-lobed, with strong interr radial notches, covered, except on a portion of the radial shields, with small, exposed, imbricated scales, which usually bear a single short, conical, acute, nearly smooth spinule. The radial shields are rather small, separate, partly naked; the exposed part is narrow and elongated, somewhat crescent-shaped. The proximal sides are incurved and somewhat divergent, separated by several rows of small scales bearing conical, acute spinules. Scales bearing acute conical spinules, similar to those of the upper surface of the disk, but longer, cover the bases of the arms and the margin of the disk, toward the oral shields, the scales become much smaller and are usually without spinules.

The oral shields are large, broad, obovate, rather longer than broad, with rounded ends. The madreporic shield is larger and has a more prominent distal end. The buccal plates project but little beyond the oral shields. The adoral shields are very narrow, wedge-shaped, inconspicuous, and do not meet proximally.

The oral papillæ are about five on each edge of the jaw, besides a terminal tooth papilla, the outer one is broad, ovate, obtuse, flat, and wider than the others, which are conical, pointed, and decrease proximally; tooth-papillæ small, spiniform, arising from the dental plate.

Under arm-plates are mostly broad, widest proximally, trapezoidal, with the distal end evenly curved and the inner end truncated, and broadly in contact. They are broader than long; those near to the base of the arms are narrower;



the first is very small, quadrant-shaped. One large, flat, elliptical or broad-ovate tentacle-scale, nearly as long as the under arm-plate, and usually a minute one in front of it. In a few cases the first tentacle-scale is bifid.

The arm-spines are about six, and are unusually short and smooth for this genus. Their length is about equal to the breadth of the under arm-plates. They are not very unequal; the lower ones are usually the largest; most of them are truncate or blunt, distinctly flattened, tapered, and curved backward; the lower ones are usually more tapered, nearly straight, subacute. They are dull and opaque, not thorny nor serrate, but microscopically roughened.

The proximal upper arm-plates are broadly in contact, broader than long, six-sided or subtrapezoidal, with the inner end truncate; the outer end, which is broadly convex or subtruncate with a median sinuosity, is much the widest. Distally they become relatively narrower and more nearly triangular, with rounded angles.

Color, in alcohol, light buff.

The larger specimens have a disk 11 mm. across; the arms are all broken.

Station 13, off Havana, in 200 fathoms, three examples.

OPHIOPRISTIS *Verrill*. (See p. 39.)

OPHIOPRISTIS ENSIFERA *Ver.*, sp. nov.

PLATE IV; FIGURES 1—1d.

Arms five, long and slender, with flat serrate spines. Disk flat, slightly ten-lobed, covered thickly, except on a part of the radial shields, with small obtuse and conical granules, mixed in some parts with minute, sharply conical spinules; all gradations in form, from the rounded granules to the conical spinules occur. Where the granules are partly rubbed off, in dry specimens, the surface is covered with small, distinct, imbricated scales. The radial shields are small; the naked

portions are ovate or elliptical, nearly parallel, and separated by several rows of scales and granules. They appear to extend but little beyond the exposed parts.

Upper arm-plates, except the basal ones, are rhombic or nearly lozenge-shaped, with a slightly angulated prominence in the middle of the outer margin, corresponding to a low median ridge; lateral margins slightly convex; proximal end angulated, slightly separated by the lateral plates. They are broader than long.

Under side of disk covered with minute, exposed scales, with few granules. Oral shields about as long as wide, rather rhombic, with rounded side angles, and a more prominent inner angle; the outer end projects slightly into the interradial area; the sides do not touch the side arm-plates. Adoral shields are long, narrow, irregularly trilobed, the distal end, embracing the lateral corners of the oral shield and touching the first under arm-plate, separates the latter from the oral shield.

Outer oral tentacle-pore large and exposed on the edge of the jaw, bordered by some small papillæ. Oral papillæ small, conical, acute, numerous, about seven to twelve on each side of a mouth-slit, of which four to seven form a proximal marginal row; others, in the largest specimens, lie within the slit, above and around the large tentacle-pore; those next the tip of the jaw are the largest. Several others (about 4 to 6 in the larger specimens) form an irregular row below the oral tentacle-pore, on the surface of the jaw. In the younger specimens there are about three in a regular row. Tooth-papillæ two, spiniform, situated at the edge of the dental plate. Teeth stout, flat, five or six.

Under arm-plates, except a few basal, irregularly trapezoidal or broad shield-shape, about as wide as long; the distal end broadly rounded; lateral edges strongly incurved; inner end very obtusely angled; scarcely separated by the lateral plates, except the two or three basals. Beyond the middle of the arm they become oblong, shield-shaped, and a little more

separated. The first one is small and deeply concave, or sheath-like, with two inner, vertical, flat crests. Tentacle-scales flat, ovate, of moderate size; on the first three or four joints there are, in large specimens, usually two; on the rest only one. The proximal tentacle-pores are not very distinctly larger than the rest.

Arm-spines unequal, rather long, scarcely translucent; the dorsal ones are not approximate in the basal rows; the upper spines on the basal joints are mostly long, rather slender, flat, tapered, subacute, roughened by minute, close denticles along each edge. Those lower down become a little shorter, stouter, and flatter, and are mostly somewhat bent, obtuse at tips, and with sharply serrulate edges. (See figs. 4-5). There are usually five spines in each row proximally.

Color in alcohol, yellowish white.

Diameter of disk 12 mm; length of longest arm, broken at tip, 65 mm.

Off Havana, 110 to 260 fathoms.

#### OPHIOPRISTIS HIRSUTA (*Lyman*).

*Ophiacantha hirsuta* Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 12, pl. II, figs. 21-23, 1875; Bull. Mus. Comp. Zool., V, 9, p. 230; op. cit. X, p. 261; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 198, 1882.

The specimens in the collection differ considerably from Mr. Lyman's figures. In all, the spinules of the disk are much more numerous than figured. In some they are mostly very long and slender, as figured; in others they are much shorter, but slender and sharp. The radial shields are covered by the small scales and spines, except near their ends, which are sometimes in contact and sometimes separated by a few rows of minute scales. The under side of the disk is covered by naked, smooth, thin, rounded scales, with few spinules. Oral shields large, round-rhombic, about as long as wide, with a distinct, but small, distal lobe, (not evenly rounded, as figured); the inner angle is obtusely rounded; the in-

ner sides nearly straight, (as in the figure). The adoral shields are very incorrectly figured, the distal lobes being omitted. They are three-lobed; inner lobe is narrowed and tapered to the end; the distal end curves around the oral shield, one lobe touching the first under arm-plate and the other separating the oral shield from the side arm-plate (as in *O. ensifera*). The first under arm-plate is small, concave, with a thin, flat, vertical crest, near each inner angle, running inward and upward and forming part of the rim around the large, exposed, oral tentacle-pore, which is situated in a depression of the jaw-margin and gives exit to a large and long tentacle. Teeth four or five, stout; the uppermost longer and conical; the others flat and stout, obtuse. Tooth-papillæ two, conical, at the tip of the jaw on the small apex of the dental plate. Mouth-papillæ about seven, in a close row, small, spiniform, acute, the outer largest (all nearly as figured). Nearly all are attached to the buccal plate, but the two outer ones stand below the tentacle-pore like tentacle-scales. In some specimens there are two or three similar papillæ above the tentacle-pore, within the mouth-slit, (as in *O. ensifera*).

The under arm-plates are quite unlike Lyman's figure. The proximal ones are broad and short shield-shaped, slightly separated by the side plates; the distal edge is evenly curved; the outer angles prominent and acute, the sides much incurved at the tentacle-pores; the inner end very obtusely angulated. They have two faint diagonal lines crossing them; the outer edge is a little raised and thickened.

Tentacle-scales two on several joints, flat, ovate-lanceolate, acute. Arm-spines about five; the upper ones on the basal joints long, slender, tapered, acute; the middle ones, on the joints further out, are mostly flattened, with finely serrulate edges (as figured); the lower ones are usually the most slender. The spines are hollow, and glassy when wet. The upper arm-plates are rather small and considerably separated, shaped nearly as in Lyman's figure; they are slightly carinated and the middle field is whitish, so that a pale median line

runs the whole length of the arm; a narrow whitish transverse band marks the inner edge of the side arm-plates, and sometimes both edges are bordered with white. One example, from the Blake Expedition, in alcohol, has a very distinct white dorsal line on the arms, and they are also crossed by a few broad white bands. The ground-color of the arms and disk, above, is light chocolate-brown; beneath, nearly white. Diameter of the disk of the largest specimen described above, 11 mm.

Stations 13 and 15, off Havana, in 200 fathoms, two examples. Taken at many stations by the Blake, in 82 to 955 fathoms.

OPHIOTRETA Verrill, subgenus (See p. 44).

OPHIOPRISTIS (*Ophiotreta*) LINEOLATA (Lym.)

*Ophiacantha lineolata* Lyman, Bull. Mus. Comp. Zool., Vol. X, p. 258, pl. VI, figs. 79-81, 1883.

*Ophiacantha*, sp., Nutting, Narrative, p. 81, (color).

An excellent specimen of this rare and beautiful species is in the collection. Only a single specimen was taken by the Blake Expedition and described by Mr. Lyman. Although there can be no doubt as to the identity of our specimen with this species it differs in several particulars from Mr. Lyman's figures. These differences are, no doubt, partly individual variations, but others are probably due to errors in the figures, for the latter do not agree well with the description, especially as to the spines. Our specimen has, on some of the arms, two tentacle-scales to a pore, on at least ten joints, instead of only on one joint. The mouth-papillæ and tooth-papillæ are somewhat differently arranged. The under arm-plates and especially the adoral shields do not agree with the figures. The upper arm-plates are wider but of the same character. The six or seven arm-spines are nearly smooth and terete and evenly tapered, without any serrulations visible with a lens. They have a fine silky appearance quite unusual in this group, but they are figured as distinctly serrulate or thorny.

The disk is nearly round and evenly swollen, without any abrupt rise over the arms; the granulations, in fact, extend out a little on the arms. The whole surface, above and below, is uniformly covered with small, smooth, rounded granules. On some portions there are, also, a few scattered, slender, acute smooth spines, as figured. Radial shields are not even indicated by ridges. Under the granules are very small scales. The arms are narrow and high, with a slight dorsal carina. They are not beaded, for the side arm-plates project but little. The rows of spines do not approximate dorsally. The upper arm-plates are thick, elevated, about as wide as long, five-sided, or on some joints six-sided; the outer end is widest and is prominent, in the middle, where it is obtusely angulated, or often slightly truncated. The proximal sides are nearly straight and convergent; the inner end is narrow and truncated, and in contact with the preceding plate.

The oral shields are nearly broad "heart-shaped," but without any notch in the outer end, which is broadly rounded with a slight median angle, and has a row of twelve or more small granules along its margin; the inner sides are slightly incurved; the acute inner end extends far inward on the jaws.

The adoral plates are narrow and long, and do not meet proximally; they are three-lobed; one of the distal lobes joins the first arm-plate; the other is very narrow and extends out between the oral shield and the first side arm-plate, slightly separating them. In Mr. Lyman's figure these parts are left indefinite. The whole surface of the jaw, proximal to the oral shields, is covered with a close group of granules, some of which are conical and similar to the mouth-papillæ and tooth-papillæ alongside of them, so that they are liable to be confounded. Of true mouth-papillæ there are either five or six on different jaws, besides a more distal short oral scale. The two outer mouth-papillæ are larger and broader than the rest; they may be ovate or obovate, flat, obtuse, or sub-



truncate; sometimes the more distal is the larger, and sometimes the one next the distal. The three or four inner ones form a close row; they are rather slender conical, or compressed, acute. The tooth-papillæ (exclusive of the granules near them) seem to be ordinarily but three or four; in one case, perhaps, five; of these, two are usually above the rest, inside the mouth, and not visible from below. They are all small, conical, and variable in form. In Mr. Lyman's description, the jaw-granulations are probably confounded with the true tooth-papillæ, for he gives a large number;—"a cluster of a dozen." At the distal angles of the mouth-slits there is, on each side, a vertical, flat process, looking like a small mouth-papilla from below, but it extends far up into the slit and bears a spiniform papilla at the side of the inner oral tentacle. Its outer end is rounded and forms the distal boundary of the outer oral tentacle-pore; it does not seem to be movable, and arises at the suture of the adoral shield and first arm-plate, but seems to be attached more to the adoral plate.\*

The first under arm-plate is small and concave. Four or five basal ones are scarcely separated by the side plates; they are about as long as broad, with an obtuse proximal angle; the distal end is prominent and strongly convex; farther out they become more nearly rhombic, with a distinct, obtuse, distal angle, and are then more separated.

The outer oral tentacles are very large and reach to the center of the mouth; they are not retracted, but have dried fully extended, as if they were more or less stiffened, in our specimen. Their pores are large, close to the edge of the jaw and partially exposed to view, when the outer papilla is removed. The tentacles of the two or three basal joints are rather large, those beyond decreasing rapidly. The basal

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\*It corresponds in position and use with a similar process, found in *O. ensifera*, *O. hirsuta* and other species, which in most cases seems to be developed on the angles of the first arm-plate. It is sometimes movable, but more frequently solid. (See also group F., p. 43).

tentacle-scales are two to a pore. The outer one is flat and ovate; the inner one is slender, spiniform, acute; both decrease rapidly in size and the inner one disappears at different joints on the several arms, from the fifth to the twelfth, while the other becomes lanceolate and acute.

Diameter of disk, 10 mm. The arms are all broken.

When living, according to Professor Nutting, the disk was light brown with five broad radial bands of white. This color still remains in alcohol. There are also traces of a median white line on the arms.

Off Havana, 110 to 200 fathoms. Off St. Kitts, 208 fathoms. Blake Exp.

OPHIOPRISTIS (*Ophiotreta*) SERTATA (*Lym.*)

*Ophiacantha sertata* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 326, 1869; Bull. Mus. Comp. Zool., V, 9, p. 231; op. cit. X, p. 261; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 198, 1882.

Our example differs in some respects from Mr. Lyman's description, but it agrees with specimens received from him. The species has not been figured.

The mouth-papillæ are usually six, not counting the pair of tooth-papillæ at the tip of the jaw; they form a close row; the two outer ones are broader and larger than the others, rather flat, ovate, obtuse, (not truncated as described by Lyman); they stand just below the outer oral tentacle. About four, placed more proximally, are more slender, elongated, compressed or spiniform. Tooth-papillæ usually three; close together on the edge of the jaw-tip, two are stouter than the mouth-papillæ, conical, acute; they appear to arise from the apex of the dental plate; just above these and below the first tooth, there is usually and odd median one, of similar form, but shorter, so that it is not visible from beneath.

Oral shield is usually wider and more lozenge-shaped than described, but in some of the smaller specimens it agrees fairly with the description, though by "heart-shaped" Lyman evidently did not mean "cordate" in the usual sense, for there

is no distal emargination, but rather an obtuse angle. The outer edge bears a row of five to seven small, conical grains.

The adoral plates are nearly as described; one of the narrow outer lobes separates the oral shield from the first side arm-plate; the other joins the first under arm-plate. The latter is small and emarginate on its inner end. The other under arm-plates differ a little from the description; they are nearly truncate on the inner end, or else very obtusely angulated, without any obvious "peak."

Upper arm-plates are small and nearly as described; they might be called narrow fan-shaped or quadrant-shaped, the outer end being well rounded. The arm-spines are as described, they are serrulated, but not rough for this genus; the flattened ones are finely serrulate on the edges; the basal rows are not closely approximate dorsally. The tentacle-scales are rather broad and flat, lanceolate or ovate, and do not rapidly change distally. One example has two pairs on several basal joints.

Diameter of disk, 6-9 mm.

Off Havana, Sta. 2, 110 fathoms, one example. Taken by the Blake Exp., in 123 to 411 fathoms.

AMPHIPSILA, gen. nov.

Type *A. fulva* (Lym.)

Disk rounded, covered with thin, naked scales, above and below. Radial shields narrow, separated, naked. Arm-plates distinct, above and below. Arm-spines of moderate length, numerous (five to twelve) serrulate. Oral shields clearly visible, at least when dry. A simple row of mouth-papillæ. Only two or three conical, apical papillæ in a marginal row; these may be considered as tooth-papillæ, but there is no distinct cluster of inner papillæ, below the teeth, as in *Ophiopsila*. Tentacle-scale spiniform.

AMPHIPSILA MACULATA, sp. nov.

## PLATE III: FIGURES 4. 4a.

Disk swollen, covered with rather small, thin, flat, rounded, nearly smooth, naked, imbricated scales. Naked part of radial shields long and narrow, wide apart; the inner ends somewhat divergent; the outer ends a little wider or clavate. Arm-spines seven or eight, slender, of moderate length, the upper ones about as long as a joint, decidedly flattened and tapered distally, nearly opaque, hollow and slightly rough; the two lower ones are longer and larger than the rest, more terete, blunt or truncate, rough or thorny at the tip. The basal rows do not approximate dorsally.

Upper arm-plates obovate, longer than wide, rather large, outer ends thin, obtusely rounded, sides convex; inner ends obtuse, overlapped by the preceding plate; distally they become more nearly square, with rounded angles, and about as long as wide. Under arm-plates shield-shaped, longer than wide, the outer end widest and slightly emarginate in the middle, the lateral edges concave; the inner end angulated and slightly overlapped by the preceding plate. Tentacle-scales on several basal joints two, unequal, elongated, flat, rough, ribbed, and palmate at the end, as if composed of two or more divergent spinules united together; more distally the smaller or outer one becomes short, thorny, and acute, and then disappears, while the larger one becomes spiniform and thorny.

Oral shields very distinct, four-lobed, "spade-shaped," with the distal lobe narrow and extending into the interradiar area; lateral lobes rounded; sides a little incurved; proximal end obtuse. Adoral shield long and narrow, extending back along the sides of the oral shield and slightly separating it from the side arm-plates.

Mouth-papillæ three or four in a regular row, besides three stouter conical ones that stand a little apart from the rest, in a row at the tip of the jaw, but of these only the middle one seems to be on the dental plate; the distal ones seem to be mostly attached to the adoral plates; they are rather large.

flat, lanceolate, the outer one largest. The first under arm-plate is small and bears a small process at each inner corner.

Color, in alcohol, yellowish white, with yellowish brown bars across the arms; disk with small dark brown spots.

Diameter of disk, 6 mm; arms badly broken.

Sta. 13, off Havana, 200 fathoms, one example.

#### AMPHIPSILA FULVA (*Lyman*).

*Ophiopsila fulva* Lyman, Bull. Mus. Comp. Zool., Vol. V, p. 227, pl. II, figs. 25-27, 1878; op. cit. Vol. X, p. 254, 1883.

This species was described and figured by Mr. Lyman from a single specimen.

The figure lacks many details and does not agree well with the description, but both differ so decidedly from our specimen of *O. maculata* that it seems useless to unite them. A direct comparison of specimens, however, might possibly show that they are varieties of one species.

West Indies, 13 to 175 fathoms, Blake Exped.

#### OPHIOMITRA Lyman.

Bull. Mus. Comp. Zool., Vol. I, p. 325, 1869; Voyage Challenger, V, pp. 202, 209, 1882, pl. XLV, figs. 4-6, (anatomy).

This genus is very closely allied to *Ophiacantha*. The only special distinctions given by Lyman are the larger size and nakedness of the radial shields, and the naked or nearly naked scales of the disk.

Mr. Lyman also described the disk of the type-species as rounded and cap-like—a character due, perhaps, to immaturity, for in large specimens of that species the interrational margins are incurved or emarginate.

When adult, the type-species (*O. valida* Lym.)\* has numerous spiniform, clustered mouth-papillæ and tooth-papillæ.

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\*The specimens originally described and figured by Lyman were all immature, and had not developed the true characters of the mouth-parts.

The distal oral tentacle-pore is large and sub-marginal, partly sheathed by proximal processes from the concave first under arm-plate and inner side of the jaw.

The adoral shields are very broad, but wholly proximal to the small oral shields. The basal tentacle-pores are large and furnished with two prominent tentacle-scales.

The large, broad radial shields are largely in contact. The disk-scales are not large, of nearly uniform size, without specialized marginal ones, and bear short, coarse, clavate, thorny stumps.

The arm-spines are numerous, somewhat thorny and glassy. The dorsal arm-plates are slightly separated by the side-plates.

Most of the species, subsequently described by Mr. Lyman and others, differ much from the type in several characters.

They nearly all have a single odd tooth-papilla and a single row of mouth-papillæ, as in typical *Ophiacantha*. The interradi al marginal scales are usually large and specialized. The radial shields are often entirely separate and in some cases not particularly large.

#### OPHIOMITRA VALIDA Lyman.

*Ophiomitra valida* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 325, 1869; op. cit., X, p. 264, 1883; Lyman, Ill. Cat. Mus. Comp. Zool., VI, pl. II, figs. 4-6; Report Voy. Challenger, Zool., Ophiuroidea, V, p. 209, pl. XLI, figs. 4-6, 1882.

Station 35, off Key West, 90 fathoms, eight examples; Sta. 33, off Sand Key, 105 fathoms, two examples; Sta. 56, Pourtales Plateau, 200 fathoms, one example. Found throughout the Caribbæan Sea, at various depths, from 10 to 1105 fathoms. (Lyman).

#### OPHIOMITRA ORNATA Ver. sp. nov.

##### PLATE V; FIGURES I, 1A.

Arms five, spines numerous and very long, tapered, acute, glassy, covered with small, rough prickles on all sides. Disk-



scales visible, not very large, of nearly uniform size, most of them bear a single, rather long tapered spine or shorter, acute, very thorny spinule. The central scales bear the shortest spinules, while the length increases toward the margin of the disk. Radial shields large, broad, irregular or roundish, partly naked, slightly bilobed distally. The under side of the disk is covered with flat, imbricated, subequal scales, bearing a few small, conical spines. The radial shields are partly separated by a narrow row of small scales, bearing short, conical, thorny spinules, similar to those on the central part of the disk; a few similar spinules arise directly from the radial shields. The interradiar margins, in one dry specimen, were rather deeply emarginate; in another, equally dry, they were strongly convex.

The oral shields are small, broadly pelecoidal, wider than long, with the distal end evenly rounded, and the inner margins strongly incurved, and forming an acute proximal angle. The madreporic shield is much larger and more rounded (pl. V, fig. 1a). The adoral shields are very large and broad, rounded distally, with the adjacent edges joined extensively, along the median line. The mouth-papillæ and tooth-papillæ together, are about twelve to fifteen on each side of a jaw; they are nearly equal, large, spiniform, acute. Those along the distal part of the jaw may form two crowded rows; the tooth-papillæ form a crowded cluster of four or five or more at the tip; five or six, or more, serving as oral tentacle-scales, form a close distal cluster.

First under arm-plate small, concave, with a pair of processes on the inner angles. Under arm-plates, except on the basal joints, broadly triangular, with the distal side broadly rounded and slightly emarginate in the middle; lateral angles very prominent; inner margins nearly straight, forming a sharp median angle. The lateral plates meet along the median line and separate both the dorsal and ventral plates, more or less.

Tentacle-scales two on one or two basal joints; one of



these is much the larger, acute, lanceolate, concave, erect; farther out they rapidly decrease and become narrow, blunt or clavate and thorny at the tip.

The arm-spines are translucent, long, slender, terete, tapered, mostly acute, and roughly serrate or thorny; the upper ones are considerably longer and more slender than the lower ones. The rows are dorsally approximate. There are eight or nine spines in the larger rows.

The upper arm-plates, except the basal, are broadly rhomboidal; the outer margins form an obtusely rounded angle; side angles very acute; inner angle obtuse, but often with an acute tip. They are separated by the side plates. Basal plate short, transversely elliptical.

Diameter of disk of the type specimen, 11 mm; breadth of arm at base, without spines, 3 mm; length of longest spines, 4-6 mm.

Station 12, off Havana, 200 fathoms, one example; station 2, off Havana, 110 fathoms, one example.

OPHIOCAMAX AUSTERA *Verrill*, sp. nov.

PLATE VI; FIGURES 1, 1a. PLATE VII; FIGURE 2.

Rays five. Disk deeply five-lobed, covered with small polygonal scales and large naked radial shields. The small scales bear each a single, small, rough or thorny, tapered spine, some of which are elongated and others short-conical.

The radial shields are very large, acute-triangular, in contact throughout the length of the straight inner edges, but with a row of small spinules along the suture. Their inner ends are covered by small overlapping scales; their outer ends are separated by a small group of scales bearing spinules.

The under side of the disk is covered with small angular scales, bearing a few small conical spinules.

Oral shields thick, warty, small, and irregularly trilobed; the body or proximal part is transversely elliptical with an

obtuse proximal angle; the distal lobe is an elongated, narrow, oblong, blunt process, which extends out into the inter-radial area. Small, rough, granule-like and verruciform elevations occur on its proximal part, as well as on the distal. The madreporic shield is larger than the others, swollen, somewhat triangular, without a distinct distal lobe.

Adoral shields are very large, broad, quadrant-shaped, with the straight adjacent edges broadly joined.

The mouth-papillæ, tooth-papillæ, and oral tentacle-scales are all similar in form, long, acute, spiniform, and very numerous. The tooth-papillæ are about ten to a jaw, in four transverse rows, below the broader and flatter teeth; the two upper rows consist each of a pair of papillæ, side by side; the two lowest rows, near the margin of the jaw, usually consist of three each, of which the median ones are larger and like those above them. On the middle of each side of the jaw there is a crowded divergent group of 14 to 17 spiniform mouth-papillæ, some of which arise from the ventral surface of the oral plates and others from their margins; a few additional ones are situated along the inner margins, up to the tooth-papillæ. They are mostly acute, spiniform, and minutely serrulate or rough.

At the junction of the concave, first under arm-plate and the first lateral plate there is a prominence, bordering the oral tentacle-pore, and bearing a close cluster of about five or six large, acute, spiniform tentacle-scales directed inward; they are rather larger than the mouth-papillæ, but similar in form; two of these are borne on the under arm-plate and three on the corner of the side arm-plate. The first arm-plate is deeply hollowed out between the side lobes that bear spiniform tentacle-scales.

On the second and third joints there are four or five similar, but slightly smaller, tentacle-scales, in a conical group around each pore; on five or six succeeding joints there are three scales in a group, but they become thorny and more irregular and decrease rapidly in size distally; beyond the

ninth or tenth joint there are two small thorny ones, and farther out only one, which is very slender and rough.

The size of the tentacle-pores also decreases rapidly from the basal joints distally, so that even on the middle of the arm it becomes minute.

Along the basal half of the arm, beneath, there is a shallow, median groove, which increases in depth proximally; it is due to the concave form of the under arm-plates. The under arm-plates beyond the basal, are short, but transversely very wide, with the lateral angles extending far out between the side plates and up on the sides of the arms; the distal edge is distinctly three-lobed, the lobes being broadly rounded, the median a little more prominent than the lateral; the proximal end has a very obtuse median angle. They are slightly separated by the side arm-plates; on the middle of each under plate there is a slightly raised, small, rough elevation. The side arm-plates are short, but high and rather prominent; they meet both above and below.

Arm-spines seven or eight on the second and third joints beyond the disk. They increase regularly in length from the lowest, which are small and slender, to the two upper ones, which are large and long, or about as long as four arm-joints. They are slender, tapered, terete, translucent, and covered with small rough points on all sides.

The rows of spines do not approach very closely on the upper side of the arm, owing to the width of the arm-plates.

The upper arm-plates are strongly arched, rather thick and swollen, rough, with a transverse row of small verrucae on a low ridge near the distal edge. These plates, except a few basal ones, are transversely subrhombic, or rudely elliptical, with the inner end obtusely angulated and the outer end broadly convex, and often obtusely angulated medially. They are much wider than long, and are separated by deep, narrow grooves in which the side plates meet.

The first four or five dorsal plates are smaller and narrow-

er; the third and fourth are nearly as wide as long, five-sided, with corners rounded. The first is a short, transverse plate, bearing a row of minute spinules, and separated from the radial shields by one or more supplementary plates.

Diameter of the disk of the largest, 14 mm.; the arms are broken at the ends.

Station 2, off Havana, 110 fathoms, two examples.

In one specimen, probably owing to repair after injury, two of the radial shields are replaced by a mosaic of small, irregular scales, bearing spinules, and the basal dorsal arm-plates, also, are each replaced by several small pieces.

This species is closely allied to *O. hystrix* Lyman, from the same region. The latter, as figured by Lyman,\* has shorter and more irregular radial shields, separated for about half their length by a wedge of scales; the disk-plates larger and few, bearing much smaller, short, conical, thorny and sharp grains. The basal upper arm-plates are longer and more angular, trapezoidal, and more extensively in contact. The basal under arm-plates are shorter and less triangular; the under arm-plates have a less distinct central lobe; the eight arm-spines are shorter and more unequal. The mouth-papillæ, tentacle-scales, and oral shields are, however, very similar in the two forms.

*O. fasciculata* Lyman, also from the West Indies, is another similar species. It has smaller and very slender disk-spines, shorter and smaller radial shields, closely joined, and without the intervening row of spinules. The dorsal arm-plates are narrower and more widely separated; the six arm-spines are much shorter; the oral shield is broader and less lobed; the tentacle-scales fewer. The mouth-papillæ and under arm-plates are very similar.

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\*Three large specimens of this species are in the Yale Museum, sent by Mr. Lyman. Two of them agree well with Mr. Lyman's type, but the third is much like our type of *O. austera*. Mr. Lyman probably intended to include both forms under his species. But our species is really more nearly allied to *O. fasciculata* L.

OPHIOCHONDRUS GRACILIS *Verrill*, sp. nov.

Disk small; arms long and slender, tapering but little, coiled. Upper arm-plates small, thick, slightly in contact with each other. broad ovate. "top-shaped." or subtriangular with rounded angles, about as broad as long on the proximal half of the arm; outer end strongly convex, lateral angles rounded, obtuse; on the distal part of the arm they become more triangular or somewhat heart-shaped, and are separated by the side plates, under arm-plates small, thick, except the basal, broad-triangular, with rounded angles and convex outer edge, about as long as broad, separated by the side plates; the distal end is thick and raised. Tentacle-scale one. large for the genus, oblong-ovate or short spiniform, obtuse. Arm-spines eight, on the greater part of the arm short, stout, a little flattened, rather obtuse, slightly rough, nearly equal in length, or the uppermost a little longer than the others; distally they become more slender and tapered; near the base of the arm, on some of the joints, the upper spine is often twice as long as the others, tapered and acute.

Oral shield small, thick, pear-shaped, with an acute inner angle, as long as broad.

Adoral shields large, thick, and rough like the oral shields, pear-seed shaped, the inner ends prolonged, acute, and largely joined. Mouth-papillæ three on each side and an odd terminal one; they are relatively large, prominent, not crowded, obtuse, the outer one slightly flattened. The upper surface of the disk is destroyed.

Diameter of disk-scar, 3 mm; diameter of arm, without spines, 80 mm; length of arms, imperfect at tip, 20 mm.

Off Havana, 110 to 260 fathoms, on gorgonians, two examples.

This species, although the covering of the disk is unknown, differs very decidedly from all those hitherto described in the slenderness and length of the arms; elongated upper arm-spine on the proximal joints; form of arm-plates, tentacle-scales, mouth-papillæ, and oral shields.

Family, OPHIOMYXIDÆ *Ljung.* (restr.), 1866.

*Ophioscolecidae* (*pars*) *Lutk.*, 1869.

*Ophiomyxinæ* (sub-family) *Ljung.*, 1871.

*Ophiomyxidae* *Carus*, *Faunæ Medit.*, p. 96, 1884.

Disk and arms covered with thick cuticle, and usually with only a row of marginal disk-scales, and a few scattered ones imbedded in the cuticle, but visible only when dried. Radial shields small, usually with a proximal series of small supplementary scales.

Teeth and mouth-papillæ stout, flat, with the end serrated. No tooth-papillæ. True tentacle-scales generally absent. Under arm-plates small. Side arm-plates sub-ventral, bearing several rough divergent spines. Upper arm-plates rudimentary or lacking; when present, composed of small pieces. Two large, triangular, peristomial plates on each mouth-angle.

Arm-bones peculiar, belonging to the modified "hour-glass-shaped" type; with well-formed condyles on both ends.

*Ophiomyxa* is the only genus described, but it evidently includes two generic groups. The second genus has the following characters:

OPHIODERA, gen. nov. Type, *O. serpentaria* (*Lym.*)

Marginal disk-scales, are rudimentary, and the disk-scales proximal to the radial shields are lacking. No upper arm-plates. Side arm-plates may be soldered to the under arm-plates; they are not continued upward by a row of supplementary plates. Three arm-spines, enclosed by cuticle.

OPHIOMYXA FLACCIDA (*Say*) *Lutk.*

*Ophiura flaccida* *Say*, *Journ. Phil. Acad. Nat. Sci.*, V, p. 151, 1825.

*Ophiomyxa caribæa* *Lütken*, *Vid. Meddel.*, p. 10, 1856.

*Ophiomyxa flaccida* *Lütken*, *Add. ad. Hist. Ophiur.*, Pt. II, p. 138, pl. V, fig. 1, 1859.

*Ophiomyxa flaccida* *Lyman*, *Ill. Cat. Mus. Comp. Zool.*, I, p. 178, pl. II, figs. 18, 19. *Verill*, *Trans. Conn. Acad.*, I, Pt. II, p. 341, 366, 1868.



Lyman, Bull. Mus. Comp. Zool., V, 9, p. 233; Lyman, Report, Voy. Challenger, Zool., Ophiuroidea, V, p. 246, pl. XLIII, fig. 1-3, 1882, anatomy. Nutting, Narrative, pp. 132, 170.

The specimens of this species show, in alcohol, considerable variation in color; most of them are dull yellowish green, or dark olive green on the disk, more or less mottled with yellow, and frequently with rings of yellow on the arms. In some examples the whole disk is covered with irregular rings of light yellow on an olive green ground-color. The colors are usually reddish or orange in life. In the larger specimens there are often, on alternate joints, four and five spines on each side; beyond the middle regularly five, or five and six on alternate joints more distally.

Tortugas, in shallow water, ten large examples, Egg Key, young.

Common in shallow water from the Florida Keys to the Abrolhos Reefs, Brazil, and throughout the West Indies. Bermuda (coll. Goode).

OPHIOMYXA BREVICAUDA *Verrill*, sp. nov.

PLATE III; FIGURE 3.

Arms relatively short and stout, rapidly tapered. Disk relatively large, tumid, five-lobed, extending out on the arms, covered with thick wrinkled cuticle, which contains few scales except along the margin and at base of arms, where there is a row of rather stout scales. Radial shields small, obscure, roundish. Arms covered above with smooth cuticle, without upper arm-plates or granules; the rhombic surfaces of the internal plates show a median groove and are nearly in contact. Under arm-plates small, rather shield-shaped, with a deep distal notch and angulated outer corners. Side-plates large, thick and prominent. Arm-spines three, webbed together, and covered by cuticle, slender, very acute, glassy, roughly serrulate. Tentacle-pores rather large.

Mouth-papillæ four, sometimes with a minute fifth distally; they are wide, flat, subtruncate or rounded and finely serrate at the end.



Oral shields small, broad-elliptical or sub-rhombic, with rounded corners, rather broader than long. Adoral shields trilobed, separating the oral shields from the side-plates, but not meeting within.

Diameter of disk, 13 mm. Length of arms, 45 mm.

Stations 4 and 13, off Havana, in 110 and 200 fathoms.

This species has arms shorter and much stouter at base than the preceding, and they taper very rapidly, instead of being of nearly uniform breadth and slender. The arm-spines are more slender, less tapered, rougher, and more glassy. The tentacle-pores are much larger; the under arm-plates are less heart-shaped or triangular; the mouth-papillæ stouter; the marginal disk-scales larger.

#### OPHIOMYXA TUMIDA *Lym.*

*Ophiomyxa tumida* Lym., Bull. Mus. Comp. Zool., vol. X, p. 272, pl. I, figs. 1-3, 1883.

#### PLATE III; FIGURE 5.

This species was taken at many stations in the West Indian region, in 13 to 300 fathoms by the Blake Expedition.

#### OPHIODERA, gen. nov. Type, *O. serpentaria* (Lym.)

Marginal disk-scales are rudimentary and concealed by thick cuticle; the disk-scales proximal to the radial shields, are lacking. No upper arm-plates. Side arm-plates may be soldered to the under arm-plates. They are not continued upward by a row of small plates. Three or four arm-spines enclosed in cuticle, the inner one is smaller and may serve as a tentacle scale; it is sometimes forked distally. Teeth and tooth-papillæ serrate, nearly as in *Ophiomyxa*, but with finer denticles.

#### OPHIODERA STIMPSONI *Verrill.*

? *Ophioscolex stimpsoni* Lyman, Illust. Cat. Mus. Comp. Zool., VIII, p. 23, pl. I, figs. 11-15, 1875.

## PLATE II; FIGURES 4, 4a.

Arms very long and slender. Disk five-lobed, the lobes extending out a little on the base of the arms. Teeth three or four, upper one stout, spiniform, the others thicker, subtruncate.

Mouth-papillæ about five, partly slender, sub-spiniform, rough at tip, irregularly crowded in a row, nearly equal in length, but some are flattened and obtuse at tip.\* Sometimes there is also a somewhat stouter tooth-papilla. Within mouth-slits, on each side, there are two (sometimes only one) slender papillæ, between the two oral tentacle-pores.

Oral-shields exposed when dry, small, transversely elliptical; adoral shields rather small, irregularly three or four-lobed, not meeting proximally, where there is a patch of naked cuticle between them, but distally separating the oral shields from the side arm-plates.

Genital slits wide and open near the oral shields, but narrow distally and not extending to the edge of the disk, bordered by narrow, naked scales.

Under arm-plates small, but somewhat thickened, angularly heart-shaped, with a deep distal notch or emargination, the outer corners angular. They are separated by the sunken side-plates, which leave central pits or indentations. No tentacle-scale. The pores are small and round. Arm-spines three or four, divaricate, small, very sharp, rough and glassy, nearly equal, more or less webbed together and covered by cuticle when in alcohol. They keep the same character to the ends of the arms, where there are but two, borne on prominent lobes of the side-plates.

Upper arm-plates lacking. The internal arm-plates show as transversely rhombic plates separated by wider intervals.

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\*The irregularity of the papillæ may be due to some former injury and only partial restoration of these parts. Many of the papillæ lack the serrulate distal end, characteristic of the genus, and plainly seen in the other specimens described below.

Whole upper surface of disk and arms and lower surface of disk covered with thin, naked cuticle, wrinkled when dry, in which are imbedded microscopic scales, on the disk, and a row of small, but distinct, marginal scales. Sometimes there are a few minute, acute granules along the margin and on the bases of the arms. Radial shields narrow, very small, or concealed by cuticle.

Diameter of disk, 7 mm; length of arms, about 45 mm.

Another slightly larger specimen from the same station has the disk tumid, and the lobes extend out more on the bases of the arms. The cuticle is thicker and contains numerous microscopic scales, while on the lower side of the disk there are many very small, scattered, pointed granules. Similar granules are scattered on the sides and back of the arms. The lower side of the arms and disk is covered with thick cuticle that conceals the plates, even when dry, unless treated with potash.

The spines are usually four, but often three and four alternately, short, rather thick, acute, rough, the upper one largest, webbed together for half their length with cuticle.

Mouth-papillæ four or five, flattened, rounded at the end, and minutely serrate, except the outer one which is shorter and scarcely serrate. On some of the basal joints there is often a minute, slender, acute tentacle-scale, concealed by cuticle in the alcoholic specimens. Under arm-plates and oral shields as in the smaller one described above.

Another specimen, with disk 8 mm. in diameter, from station 15, has the oral shields more triangular, with rounded corners, their breadth being about equal to the length. The radial shields can be seen through the dried cuticle as very small, narrow, oblong plates, well apart.

Mouth-papillæ five, small, serrate, decreasing in size distally. Arm-plates and spines as in the others.

Station 4, off Havana, in 110 fathoms; station 15, off Havana, in 200 fathoms; station 24, off Key West, in 60 fathoms.

Family, HEMIEURYALIDÆ *Ver.*

In this family are included several genera of true Ophiuræ, which very much resemble, in form and habits, the simple-armed Euryalæ or Astrophytons. Like the latter, they coil their arms closely around the branches of gorgonian corals on which they dwell.

The disk is pentagonal and covered with thick plates or tubercles, which may be conical. The radial shields are large and prominent.

Upper arm-plates may be entire and accompanied by supplementary plates, or they may be replaced by a mosaic of small plates. They are thick or tubercular.

Under arm-plates well formed. Side-plates separated by extra plates. Oral and adoral shields normal. Spines few, short and stumpy. A row of mouth papillæ. Teeth, but no definite cluster of tooth-papillæ.

Genital pores small, situated near together at the outer end of the oral shield. Arm-bones have special forms approaching those of the *Astrophytons*. Mouth-frames strongly ossified.

The genera belonging to this family, are *Hemieuryale*, *Ophioplus*, and *Sigsbeia*.

OPHIOPLUS. gen. nov.

Type, *Hemieuryale tuberculosa* Lyman.

PLATE I; FIGURES 1. 1a, 1b.

Disk small, pentagonal, thick, covered with small, thickened or tubercular scales. Radial shields large, naked, separated. Oral shields and adoral shields well developed and naked. Mouth-papillæ in regular series. No tooth-papillæ. Under arm-plates rather large. Upper arm-plates entire, swollen and well formed, separated by a transverse row of small, tubercle-like plates. Side arm-plates prominent, separated above by a supplementary lateral plate. Arm-spines short, two or three in a row. Tentacle-scale single.

A pair of small, round genital pores under the outer end of the oral shields.

This genus differs decidedly from *Hemicuryale*, to which it is allied, in having distinct and well formed dorsal arm-plates. It is also closely allied to *Sigsbeia*. In fact, it stands between these two genera in several characters.

OPHIOPUS TUBERCULOSUS (*Lym.*) *Ver.*

*Hemicuryale tuberculosa* Lyman, Bull. Mus. Comp. Zool., vol. X, p. 276, pl. VIII, figs. 120-127, 1883.

*Ophiomusium* (?) Nutting, Narrative, p. 78.

PLATE I; FIGURES 1, 1a, 1b.

Disk small, thick, pentagonal or five-lobed, convex, swollen over the bases of the arms, covered with rather large, mostly rounded, swollen and verruciform plates, among which a central plate and ten radiating rows of radial and interradiating plates of larger size and greater elevation can be distinguished; the smaller plates are more irregular in form and less swollen. The radial shields are rough, rudely elliptical or ovate, rather long, widest in the middle, far apart, separated by a median row of about three high, verruciform plates and a row of smaller ones on each side. Upper arm-plates, except the basal, are broader than long, very thick and prominent, transversely elliptical or oblong, with all the corners rounded; outer end often a little emarginate, and inner end often truncated. They are usually separated by a single row of three, high, verruciform plates, of which the middle one is round and the laterals ovate; sometimes there is an additional row of two or three plates; at the base of the arms the median one may be lacking, and toward the tips, the laterals usually disappear, leaving only a small median one. A row of rounded prominent plates extends along each upper edge, alongside of the arm-plates, and alternating with the side-plates. Arm-spines generally two, sometimes three, small, short, stout, the lower one thickest, clavate or obtuse. Tentacle-scale rather large, ovate.

Under arm-plates, near the base of the arms, trapezoidal with convex outer edge and rounded corners, usually rather longer than broad; farther out they are nearly square, a little separated by the side plates.

Oral shields five-sided, broader than long, outer edge a little convex, angles rounded; inner edges concave, meeting in a broad angle. Adoral shields large, rudely ovate, the narrower inner ends broadly in contact. Mouth-papillæ about five, angular, acute, more or less flattened.

Genital pores very small, round, under the outer end of the oral shield.

Color deep brown, variously spotted with whitish, imitating the colors of *Gorgonella* to which it clings.

Usually many of the more prominent verruciform plates of the upper side of the arms and disk are white; under arm-plates dark brown.

Station 15 and 16, off Havana, 200 fathoms, two examples. Taken by the Blake Expedition in 96 and 115 fathoms.

#### SIGSBEIA MURRHINA *Lyman*.

*Sigsbeia murrhina* Lyman, Bull. Mus. Comp. Zool., V, 9, p. 234, 1878, pl. III, figs. 55, 58; op. cit. X, p. 277; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 250, pl. XLIII, figs. 4-6, 1882, anatomy; Three Cruises of the Blake, II, p. 114, fig. 399, 1888. Nutting, Narrative, p. 79.

#### PLATE II; FIGURES I, 1a.

Station 13, off Havana, 200 fathoms, one adult and one young; station 73, Little Cat I., 3 to 15 fathoms, three young.

This species clings to gorgonians, which it imitates in form, and probably in color when living.

A young specimen, having a disk 3.5 mm. in diameter, appears to belong to this species. It is from station 73.

This specimen differs so much from Mr. Lyman's figures that it might almost be taken for a new species, but the differences may be due to age.



In our specimen the oral shields are broader and less ovate, the outer ends being more rounded than in Lyman's figure. The under arm-plates are longer, narrower, and more shield-shaped, the sides being strongly emarginate, and the proximal end narrower; they are all, even at the base of the arms, separated by the lateral plates. The tentacle-scale is very small. The arm-spines are minute, near together, short, obtuse, the lower one slightly larger.

The basal upper arm-plate is very small, short, transversely elliptical, partly concealed by three supplementary, thickened disk-scales outside the ends of the radial shields; the second plate is larger, thick, transversely elliptical; the succeeding ones are top-shaped with rounded outer, and very acute inner ends; sides incurved, usually not separated by the lateral plates. The two basal plates are, therefore quite unlike Mr. Lyman's figure.

The disk-plates are very different from Mr. Lyman's figure; the radial shields are narrower and at their inner ends there are five large, swollen, pear-shaped radial plates, their points inward, and separated by about three small scales, and with a small central scale. None of the disk plates bear tubercles or granules. The disk is high and swollen and the plates are not closely soldered together, as they are said to be by Mr. Lyman. Color of the dry specimen yellowish brown above, yellowish white below.

## Order II. EURYALÆ Müller & Troschel, 1842.

*Euryalidæ* Gray, 1840.

*Astrophytonidæ* Norman, 1866.

*Phytastra* Hæckel, 1866.

*Astrophytidæ* Lyman, Ljungman and others.

*Euryalæ* Ljung., Oph. Viv., p. 334, 1867. Carus Fauna Medit., p. 97, 1884.

*Cladophiuræ* Bell, 1892.

*Euryalida* of several authors.

## Family, ASTRONYCID Æ, nov.

*Astronycina*, (pars) Ljung., Oph., Viv., 1867.

Arms undivided, long, slender, coiled, not annulated nor granulated. Disk with ten narrow radial ridges formed by long narrow radial shields, covered with thin, smooth scales or naked skin. Teeth stout, well formed, in a single row. Tooth-papillæ one or two, conical, sometimes absent. Mouth-papillæ small, like conical granules, placed above the margins of the jaw. Oral and adoral plates regularly formed.

Upper and under arm-plates rudimentary or absent. Side-arm-plates cover most of the lower side of the arm and project laterally, bearing two, three, or more spines or tentacle-scales, which may be either simple or hook-like. The genital slits are short, near together, in a depression near the oral shields.

*Astronyx* was the only described genus of this family, till recently, when I was able to add to it a new genus, *Astrodia*, (type *A. tenuispina* Ver.) from deep water off the U. S. coast.

This family includes only two genera, *Astronyx* M. & Tr., and *Astrodia*.

## ASTRONYX LYMANI Verrill, sp. nov.

*Astronyx loveni* Lym., Bull. Mus. Comp. Zool., vol. X, p. 282, pl. VIII, figs. 136-138, young, (non Müll. & Troschel).

## PLATE VIII; FIGURES 4-4c.

Arms five, long, slender, coiled. Disk pentagonal with incurved margins, and ten high, long radial shields, which are widely separated, curved outward in the middle and somewhat sinuous distally, the outer end a little clavate or knobbed; the edge is serrulate with small scales. The radial shields and disk are covered with a thin, smooth skin which extends out on the arms above and below. Interbrachial region below, in the dry specimen, concave or sunken, with the two short but wide genital openings close together, near the inner angle.

Tooth-papillæ about six, in a biserial group at the end of the jaw, small and conical; two or three similar mouth-papillæ on each jaw-margin, rather irregularly arranged, and others higher up in the slits. On the first joint the tentacle-pores are without scales or spines; on the second they sometimes have a single, very small one; on the third there are either two or three small spiniform ones; on the fourth usually three in each group, of which the inner is longest; on the fifth joint, opposite the edge of the disk, there are three, the inner or lower one being much longer and more spiniform than the others, which have claw-like hooks on the lower side. Farther out the number increases to four, and finally to six, beyond the middle of the arm. The large, lower one is about as long as a joint, blunt, and rough on the inside, on the basal joints, but farther out it becomes obtuse and its distal part bears ten, twelve or more small glassy hooks, in two or more rows (figs. 4, 4*a*, 4*e*); those of the upper series are all changed to claw-like hooks, the lower often with two or three glassy points; they are attached to a transverse row of prominent tubercles on the side arm-plates (figs. 4*a*, 4*b*, 4*c*). Still farther out the lower spine is reduced to a claw, with two or three points (fig. 4*d*). Near the tip of the arm there are only two or three hooks in each row.

Diameter of disk of type, 15 mm; of arm at base, 4 mm; length of arms, broken, 100+mm.

Station 16, off Havana, 200 fathoms.

This species resembles *A. loveni* in appearance. The latter has the smaller arm-spines more nearly equal, shorter and less strongly clawed; the lower one is more conical and the roughnesses are not so claw-like on the basal joints. Toward the base of the arm there may be four or five slender, tapered, nearly equal, divergent spines, but they all change to claws distally. The mouth and tooth-papillæ are fewer, smaller, and less acute.

*A. locardi* Kœhler,\* from the eastern Atlantic, in 1710 m.

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\*Rev. Biol. du Nord de la France, vol. VII, p. 34, 1895.

is another similar species. It differs in having the proximal arm-spines, short, stout, obtuse, slightly bent, six or seven at the tenth joint, the length increasing gradually from the lowest to the upper ones, but showing no marked difference in length, even between the first and second.

Family, A S T R O S C H E M I D Æ, nov.

Arms simple, long, slender, coiled. Disk five-lobed, with ten radial ribs; naked or granulated. Radial shields narrow, usually elongated.

Teeth large, stout, several in a vertical row. Mouth-papillæ small or wanting.

Under arm-plates small. Upper arm-plates poorly developed, often wanting, sometimes represented by two or more pieces, covered by naked skin or granulated.

Side arm-plates relatively large, covering a large part of the lower side of the arm, and usually bearing two elongated spines or tentacle-scales.

Oral and adoral plates regularly formed, but covered by cuticle.

Genital slits short, situated near the outer margin of the disk.

Mouth-frames strong, well developed, but without wing-like processes.

This family includes *Astroschema*, *Astrocreas*, and *Ophiocreas*.

ASTROSHEMA OLIGACTES *Lütken*.

*Asterias oligactes* Pallas, Acad. Caes. Leop. Nova. Acta., II, p. 239, pl. VI, fig. 23.

*Astroschema oligactes* Lütken, Vid. Meddel., p. 16, 1856; Add. ad. Hist. Oph., Pt. II, p. 155, pl. V, fig. 3. Duj. & Hupé, Hist. Nat. Zooph. Echin., p. 297, 1862. Lyman, Ill. Cat. Mus. Comp. Zool., VIII, Pt. II, p. 62. Verrill, Trans. Conn. Acad., I, p. 341. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 278, pl. XLIV, figs. 1-5, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 280.

*Ophiocreas*, sp., Nutting, Narrative, p. 80.

Stations 4 and 13, of Havana, 110 to 200 fathoms, three examples; station 29, off Sand Key, 116 fathoms, one example; station 15, 200 fathoms, three examples. Taken by the Blake Exped., in many localities, in 69 to 288 fathoms.

Like the allied species, this clings to certain gorgonians that it closely imitates in form and colors.

One six-rayed specimen was taken off Havana.

*ASTROSCHEMA ARENOSUM* Lyman.

*Astroschema arenosum* Lyman, Bull. Mus. Comp. Zool., V, 9, p. 23, pl. III, figs. 62, 64, 1878; op. cit. X, p. 280; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, 278.

*Ophicreas* sp., Nutting, Narrative, p. 80.

Station 29, off Sand Key, 116 fathoms, one example; station 37, off Key West, 125 fathoms, one example. Taken by the Blake Exped., in 124 to 805 fathoms.

*ASTROSCHEMA INTECTUM* Lyman.

*Astroschema intectum* Lyman, Bull. Mus. Comp. Zool., V, 9, p. 235, pl. III, figs. 59-61, 1878; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 278.

*Ophiocreas*, sp., Nutting, Narrative, p. 80.

Station 13, off Havana, 200 fathoms, three examples. Taken by the Blake Exped., in 175 fathoms.

*ASTROSCHEMA NUTTINGII*, sp. nov.

PLATE VII; FIGURES 3, 3a.

Five long, slender, curled arms. Disk five-lobed, with ten prominent radial ridges (when dry), extending nearly to the center; its whole surface is covered with minute, rough, rounded granules, those on the ribs distinctly coarser and more crowded than the rest; those in the depressions between the ribs very minute and scattered, showing the naked skin between them; the skin is divided into small areas, which appear to cover small imbedded scales.

Upper surface of the arms without visible dorsal plates, covered with thin naked skin containing very minute granules, becoming more distinct distally. The outlines of the internal arm-plates can be seen. Near the tips of the arms small scattered granules occur.

Under side of disk and arms everywhere apparently naked, except for a few granules around the genital slits and mouth-angles, but the skin, when dry, is filled with minute rough grains, visible only when much magnified.

Mouth-papillæ five or six in a regular row, small, conical and granule-like; larger conical papillæ occur at the tip of the jaw. A pair of minute, conical, oral tentacle-scales at the outer corner of the mouth slits.

Spines or tentacle-scales on the first joint one, minute and sometimes lacking; on the second joint generally one or two, long and slender; on succeeding joints two rather long, about equal to breadth of arms, slender, tapered; the lower one is longest and largest, cylindrical, blunt, or even a little enlarged toward the end, and covered near the tip with rough spinules; on those close to the end of the arms the terminal spinules become almost claw-like. The upper spine is also roughened in the same way, but less distinctly so.

Color, in alcohol, light buff.

Diameter of disk, 7 mm; length of arms, about 50 mm.

Station 33, off Sand Key, 105 fathoms, one example; station 37, off Key West, 125 fathoms, one example.

Probably attached to gorgonians or hydroids.

#### OPHIOCREAS LUMBRICUS Lyman.

*Ophiocreas lumbricus* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 347, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 19-21; Bull. Mus. Comp. Zool., V, 9, p. 236; op. cit., X, p. 281; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 284, 1882. Nutting, Narrative, Bahama Exp., p. 171, pl., fig. 1.

Station 4, off Havana, 110 fathoms, one example; stations 26, 28 and 48, off Key West, 60, 116 and 80 fathoms, four-



teen large examples; station 33, off Sand Key, 105 fathoms, four examples; station 62, off American shoal, 70 to 80 fathoms, four examples.

This and the allied species cling to gorgonian corals, which their long, slender arms imitate in form and color.

OPHIOCREAS SPINULOSUS *Lyman*.

*Ophiocreas spinulosus* Lyman, Bull. Mus. Comp. Zool., X, p. 281, pl. VIII, figs. 132-135, 1883; Three Cruises of the Blake, p. 109, fig. 389, 1888.

Station 28, off Sand Key, 116 fathoms, two large examples. Taken by the Blake Exped., in 116 to 288 fathoms.

Family, ASTROCHELIDÆ, nov.

Arms simple or with a few distal forks, granulated, and also annulated with raised ridges. Disk with five or ten radial ridges, its surface granulated or spinulose.

Teeth and tooth-papillæ numerous, spiniform; the latter form an apical cluster. Mouth-papillæ similar in form, sometimes lacking. The teeth may form double vertical rows. Under arm-plates rudimentary or lacking. Side arm-plates cover most of the under surface, but are hidden by cuticle and granules. They bear a short row of small rough spines or tentacle-scales; above them are double vertical rows of small plates,\* forming raised ridges and bearing granules and also rows of minute glassy hooks, on the sides and top of the arms.

These sometimes extend on to the radial ridges of the disk. The genital openings are short, situated toward the margin of the disk or not close to the inner angle.

This family includes *Astrochele*, *Astrogomphus*, *Astroporpa*

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\*Mr. Lyman considered these the equivalent of the upper arm-plates, but to me they appear to be a continuation of the side-plates. In this case the upper plates would be represented, if present, by the rows of small plates between the ridges.

and *Astrotoma*, with simple arms, and *Astrocnidu* with the arms forked near the ends.

*ASTROGOMPHUS VALLATUS* Lyman.

*Astrogomphus vallatus* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 350, 1869; Ill. Cat. Mus. Comp. Zool., VI, pl. I, figs. 16-18; Bull. Mus. Comp. Zool., V, 9, p. 236; op. cit. X, p. 229, 279; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 271, pl. XLIV, figs. 10-12, 1882, anatomy. Nutting, Narrative, p. 171, pl., figs. 2, 2a.

The larger specimens usually have five arm-spines on the proximal part of the arm, but sometimes only four, or five and four irregularly alternating. A very large one has six spines on some of the basal joints, the extra one being external to the others and smaller. The spiniform single tentacle-scale of the first joint is often wanting on some of the arms. The second joint usually has four spines (or tentacle-scales), in form like those of the following joints. The disk has a definite marginal row of rough spinules; the interbranchial spaces and most of the oral region appear smooth in alcohol, but when partly dried have a fine tessellated appearance; when quite dry these parts are covered with a close mosaic of larger and smaller mostly flat granules, the larger ones being somewhat conical. The cluster of spinules in the interradial angles is pretty clearly circumscribed, but one spinule often stands a little apart and more towards the mouth-angle. The madreporic shield is small, roundish, and just outside one of the groups of interradial spinules.

Stations 28 and 29, off Sand Key, 116 fathoms, 40 examples; station 56, Pourtales Plateau, 200 fathoms, four examples; station 64, off American Shoal, 110 fathoms, four examples; station 62, 70 to 80 fathoms, two examples.

It was taken by the "Blake" in many localities throughout the West Indian region, in 88 to 337 fathoms.

It is found clinging to branches of *Gorgonella* and other gorgonian corals, which it imitates closely in colors.

One large specimen from Station 56 has repaired extensive

mutations, having lost about one-third of the disk and two entire arms. The new arms are about one-half grown and are perfectly formed. The new section of the disk is not full grown and has a thinner skin, fewer and smaller spinules and granules, and smaller and somewhat more irregular radial ribs than the others.

A young specimen from Station 62, with the disk 7.5 mm. in diameter, agrees pretty closely with the larger ones in the armature of the disk and arms, but on the disk the larger granules are mostly short, conical, or obtuse; only a few of them are acutely conical; the smaller ones are rounded grains; on the arms the bands of granules are a little less numerous than on the adult. There are four or five sharp, conical mouth-papillæ, the outer one small. The granules of the lower and lateral surfaces are angular and flat, forming a smooth mosaic; a single row of small conical spinules runs from the base of one arm to another on the lower side, and at the upper margin of the interbrachial region there is a less regular row of conical grains, so that the sides of the body, between the arms, has a rigid, angular appearance. The smooth granulation of the lower side of the disk extends directly out on the lower side of the arms, concealing the plates. The spines or tentacle-scales are mostly in threes, short, nearly equal, oblong, thorny at the tips.

Still younger specimens, from 2 to 3 mm. in diameter of disk, from stations 13, 35 and 62, are quite different in appearance. In these the radial shields are *naked*, elevated, and oblong-ovate, parallel, separated by one to three rows of small, round granules; a radial row of three to five similar granules extends out from the center in each interradial area; the central area shows a central and five larger, obtuse-conical, primary, radial granules and five primary interradials, with many crowded smaller granules; two small round granules are situated on the outer end of each radial shield. The granules of the upper side of the arm are small, round, and prominent; about three rows alternate with the more ele-

vated rows corresponding to the lateral spines; part of the granules of the latter bear relatively large, claw-shaped hooks with a terminal, strongly incurved claw and two or three swollen secondary denticles on its inner edge. The lateral spines are mostly three, small, short, rough or thorny at the tip. Mouth-papillæ four or five, small, rough, mostly acute, the outer one larger and obtuse.

ASTROGOMPHUS RUDIS *Verrill*, sp. nov.

PLATE VII; FIGURES I, 1A.

This species differs from *A. vallatus* in having the radial ribs wider and less raised, and the disk-spinules more numerous, shorter, and much more thorny, and not forming a definite marginal row; in having smaller, though similar, spinules on the whole under surface of the disk, up to the mouth-slits, not forming definite interradi al groups, but having small granules between them; in having more numerous and smaller mouth-papillæ and tooth-papillæ; in having wider, closer, and more even, raised, granulated bands on the arms, with much narrower sunken intervals; and in having shorter, stouter, and much more thorny tentacle-scales or spines, usually five in a group. The minute hooks on the bands of the arms are very numerous.

Station 56, Pourtales' Plateau, 200 fathoms, one example; station 28, off Sand Key, in 116 fathoms, one example.

ASTROPORPA ANNULATA *Erst. & Lütken*.

*Astroporpa annulata* (Erst. & Lütken, Vid. Meddel., p. 17, 1856; Add. ad. Hist. Oph., Pt. 11, p. 152, pl. V, fig. 4. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 270, 1882; Bull. Mus. Comp. Zool., X, p. 279, 1883. Verrill, Rep. U. S. Fish Comm., for 1883, p. 552, 579, 1885.

*Astroporpa dasycladia* Duj. & Hupe, Hist. Nat. Zooph. Echin., p. 298, 1862.

*Sigsbeia*, sp., Nutting, Narrative, p. 79.

Station 2, off Havana, 110 fathoms.

This curious species is found throughout the West Indies, in 50 to 163 fathoms. Off Cape Hatteras, 48 to 68 fathoms, on *Titanideum suberosum*, etc., U. S. Fish Comm. Off Barbados, on *Gorgonella*, Yale Museum.

This species clings to several species of gorgonians, which it closely imitates by its colors and by the form and ornamentation of the arms and disk.

#### ASTROCNIDA ISIDIS *Lym.*

*Trichaster isidis* Duchassaing, Animaux Radiaires des Antilles, 1850.

*Astrocnida isidis* Lyman, Ann. Sci. Nat., p. I, 1872; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 270, pl. XLVI, fig. 2, 1882, anatomy; Bull. Mus. Comp. Zool., X, p. 279, 1883; Three Cruises of the Blake, vol. II, p. 115, fig. 400, 1888.

Two young specimens are in the collection, labeled as from Station 69, off Cat Island, in 3 to 13 fathoms. But it is probable that this is an error, for it is known only from rather deep water (56 to 120 fathoms, Blake Exped).

This species clings to several species of *Gorgonella* and other gorgonian corals, which it closely imitates in color. Its arms also resemble the branches in form and roughnesses.

Off Barbados, on *Gorgonella*, Yale Museum.

#### Family, GORGONOCEPHALIDÆ Ljung. (restr).

*Gorgonocephalinæ* (pars) Ljung., 1867. Bell, 1892.

Arms divided dicbotomously into numerous branches. Disk swollen, with ten prominent radial ribs, covered with cuticle, which may bear granules or scattered spinules, or it may be more or less naked. Radial shields, each composed of several united plates. Teeth and tooth-papillæ numerous, spini-form. Mouth-papillæ when present, small, conical or papilli-form. Adoral shields well-developed, but usually concealed by cuticle, sometimes broken into several plates. Oral shields rudimentary or wanting. Sometimes there are five small, madreporic plates, but usually only one. Under arm-plates mostly rudimentary, consisting of two or more small pieces,

sometimes absent. Side arm-plates are united below, and cover most of the under side of the arms. They bear a row of few, small, rough spines or spiniform tentacle-scales, which are usually hook-like distally. Two or more rows of small plates run up from each of the side plates and form transverse ridges around the arms. covered with granules; these usually bear rows of small glassy hooks. The dorsal arm-plates are rudimentary or wanting. The entire surface of the arms and disk above and below is covered with cuticle which is usually granulated, so that the plates are hidden.

*ASTROPHYTON MURICATUM (Lam.) Agassiz.*

*Astrophyton costosum* Seba, (*non* Linck), III, pl. IX, fig. 1, p. 16, 1758 (not binomial).

*Euryale muricatum* Lamarck, Hist. Anim. s. Vert., II, p. 538, 1816.

*Astrophyton muricatum* L. Agassiz, Mem. Sci. Nat. Neuchatel, I, p. 12, 1835. Mull. & Trosch., Syst. Ast., p. 122. Lütken, Add. ad Hist. Oph., Pt. II, p. 156. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868.

*Astrophyton costosum* Lyman, Proc. Boston Soc. Nat. Hist., XIX, pl. 4; Illus. Catal. Mus. Comp. Zool., I, p. 192, 1865; Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 257, pl. XXXV, figs. 17-25, 1882. Nutting, Narrative Bahama Exp., p. 172.

The color is light chocolate brown, with irregular blotches of darker brown on the disk. The stout stumps on the radial ribs are variable. In some cases they are crowded, short, blunt, wart-like, and do not extend on the arms. In one example, from the Bahama Banks, each radial rib bears five or six, mostly in one row, and they are sharp and conical, while ten or twelve smaller conical spines extend along the proximal part of each arm.

A young specimen (disk 8 mm. in diameter) has but one or two stout spines on each rib; these are blunt, and in some cases two unequal spines are joined at base, as if the smaller were budding from the base of the larger; the spines are white and conspicuous against the chocolate ground-color. From four to eight smaller, blunt, white, dorsal spines occur irregularly on each arm. The outer ones, situated between



the second and third forks, become small and granule-like. Groups of small, roundish, white spots, surrounded by a circle of dark brown, occur on the radial areas of the disk. The arms are banded with brown and yellowish white, the latter becoming prominent.

It is useless to go back to polynomial writers, like Seba, for binomial names, as Lyman did for this species.

Station 68, off Little Cat I., 3 to 13 fathoms, one example; Tortugas, on anchor, 8 fathoms, one large example; Bahama Bank, one example.

This species has been taken from off Charleston, S. C., and the Florida Keys to St. Croix. It usually clings to gorgonians, having corresponding colors.

#### ASTROPHYTON CÆCILIA *Lütken*.

*Astrophyton cæcilia* Lütken, Vid. Meddel., p. 18, Jan., 1856; Add. ad Hist. Oph., Pt. II, p. 157, pl. V, fig. 6. Verrill, Notes on Radiata, Trans. Conn. Acad., I, p. 341, 1868. Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 258, 1882; Bull. Mus. Comp. Zool., X, p. 279, 1883; Three Cruises of the Blake, vol. II, p. 110, fig. 388, 1888.

*Astrophyton krebsii* Lütken, Vid. Meddel., p. 18, 1856; Add. ad Hist. Oph., Pt. II, p. 158, 1859.

Station 69, off Little Cat I., 3 to 13 fathoms, 1 young.

Not uncommon in the West Indies, in 50 to 124 fathoms, adhering to gorgonians. St. Croix, on a gorgonian (*Thesca*); off Barbados, or *Gorgonella*; and off Havana, Yale Museum.

#### GORGONOCEPHALUS MUCRONATUS *Lyman*.

*Astrophyton mucronatum* Lyman, Bull. Mus. Comp. Zool., I, 10, p. 348, 1869. Nutting, Narrative, p. 172.

*Gorgonacephalus mucronatus* Lyman, Report Voy. Challenger, Zool., Ophiuroidea, V, p. 265, 1882; Bull. Mus. Comp. Zool., X, p. 279.

The color, in life, according to Prof. Nutting, is light buffy yellow, with transverse bars of brown on the arms.

The largest specimen, sent to me, from station 33, is 48 mm. in diameter of disk. The color of each, in alcohol, is pale

yellow, with small and not very distinct spots of light brown on the disk, and a double row of the same colored spots along the upper side of the arms. There is considerable variation in the number and form of the large disk-spines. The larger specimens have from twelve to sixteen stout, conical spines on each radial rib, in two irregular rows, but in some cases these are regularly conical, in others sharply acuminate. The spines of the central group are even more variable. In most cases part of them are regularly conical, and part are blunt or rounded at summit, while others may be acuminate. In one example a considerable number of similar spines are present in the interradial spaces of the disk, and some even between the adjacent ribs. In some specimens these parts are naked; in others, granulated with scattered round-topped grains. The large dorsal spines of the arms are also variable in number and form, but are similar to those of the disk, but smaller and usually less acute; between them there are coarse round-topped granules, variable in size. The larger specimens have three tentacle-scales at the base of the arms; the smaller, two.

Station 48, off Key West, 80 fathoms, 1 young; station 62, off American Shoal, 80 fathoms, 1 young. Prof. Nutting refers to it as "common" below 100 fathoms, but only two specimens were sent to me.

It was taken by the Blake Exp., off Florida, in 120 to 125 fathoms, and amongst the West Indies, in 218 to 288 fathoms.

This species clings to gorgonians, of several kinds, which it imitates in form of arms and color.

## ERRATA.

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Page 7, line 11, for FIGURE 4, read FIGURE 3.

Page 9, line 13, omit Figures 3, 4.

Page 11, line 26, for varietel, read varietal.

Page 13, line 16, for  $3c$ , read  $3c$ .

## EXPLANATION OF PLATE I.

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The figures were drawn from nature by A. H. Verrill.

- FIG. 1. *Ophioplus tuberculosus* (Lym.) Ver. Dorsal surface.  $\times 8$ .  
FIG. 1a. The same. Side view of several joints from the middle portion of an arm.  $\times 8$ .  
FIG. 1b. The same. Distal part of an arm, dorsal view.  $\times 8$ .  
FIG. 2. *Ophiacantha* (*Ophialcæa*) *nuttingii* Ver. Side view of a portion of an arm, near the base, showing three rows of spines.  
FIG. 3. *Ophiomusium stellatum* Ver. Dorsal view of a part of the disk and base of an arm.  $\times 8$ .  
FIG. 3a. The same specimen. Ventral view.  $\times 8$ .